

Daily report

10-05-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓ α : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓ K : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to datapoints. We also discuss a specific issue every day.

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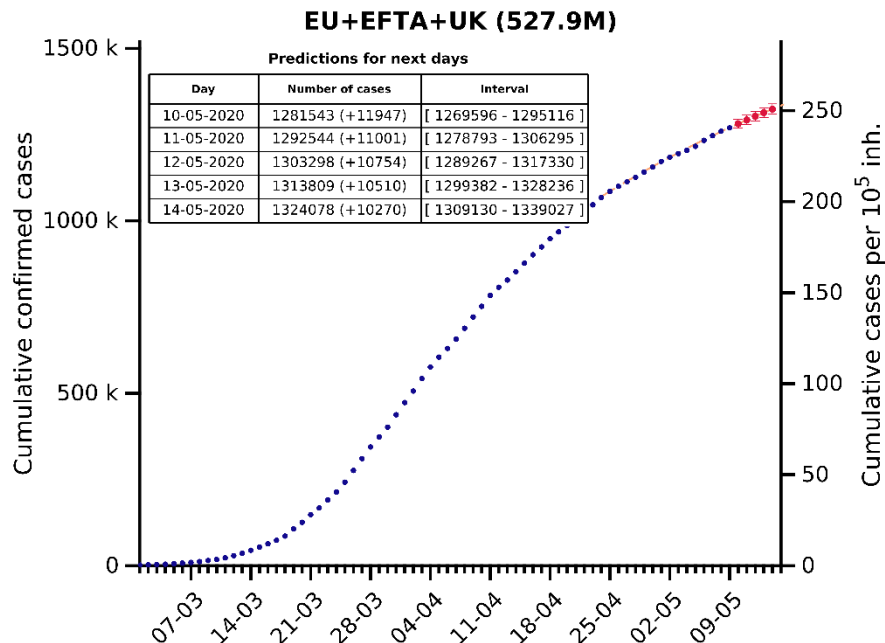
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(0) Executive summary – Dashboard

Weekend short version

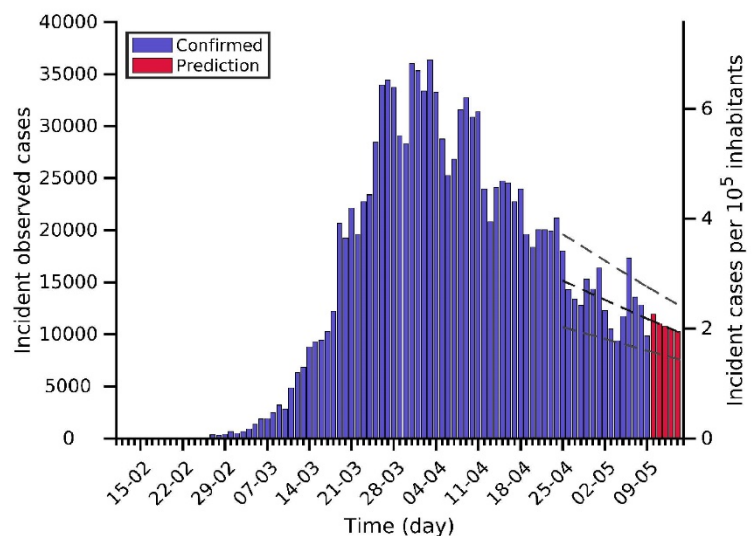
Attack rate and short-term predictions in EU+EFTA+UK

Short-term predictions, based on last 15 points with increased weight on last 3:



Highlights and/or warnings

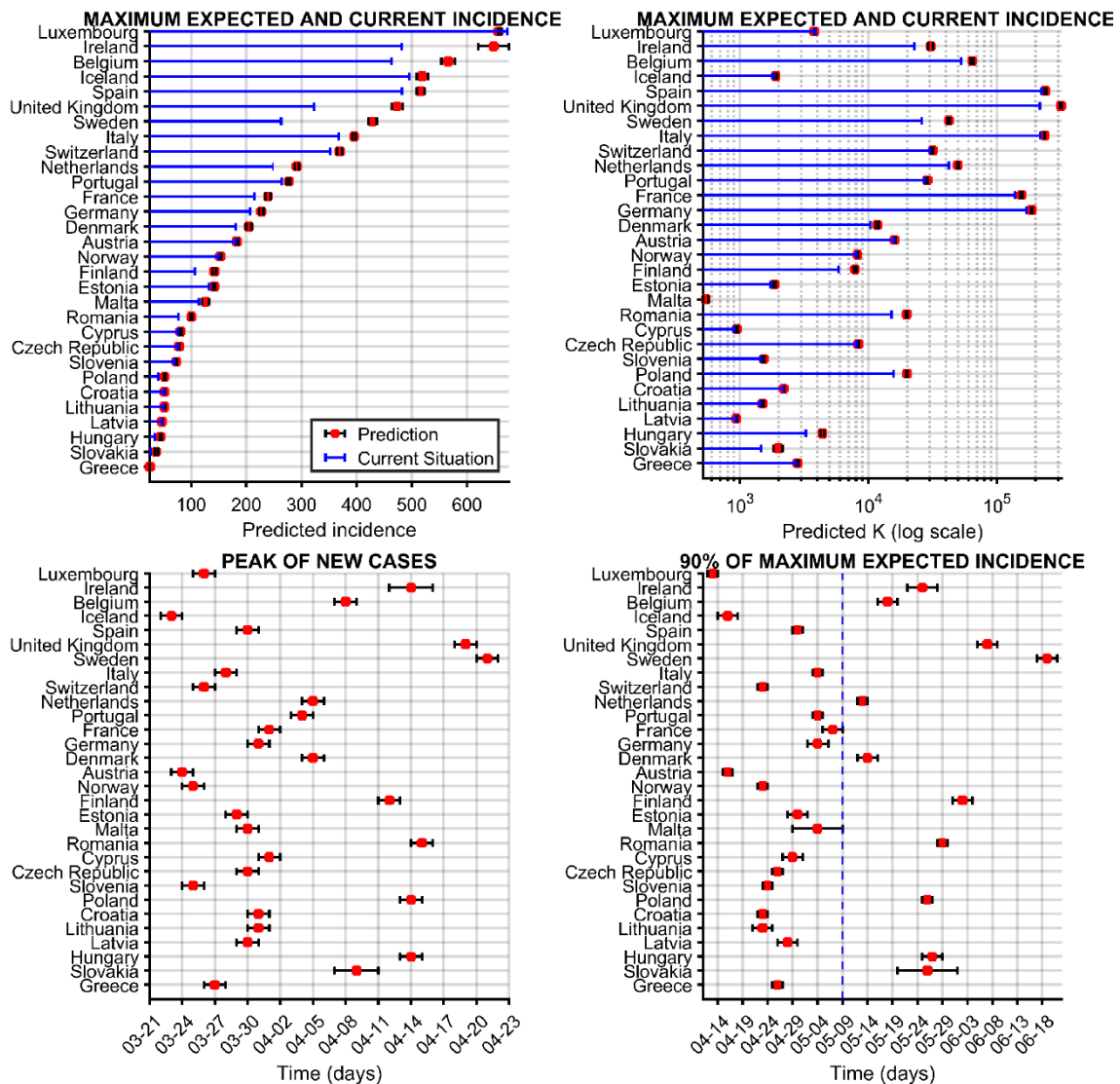
- UE+EFTA+UK new cases are shown in the figure.
- United Kingdom maintains its compromised situation, but has returned to the level of 4,000 new cases.
- High ρ_7 shown by France, Portugal, Croatia, Slovakia, Slovenia and Malta is not necessarily indicative of high spreading rate, since it is strongly affected by a one-day spike or a zero in data reporting.
- There are several countries at $\rho_7 \approx 1$ but with low A_{14} (see table). These cases are not worrying if a significant increase is not observed in the next days.



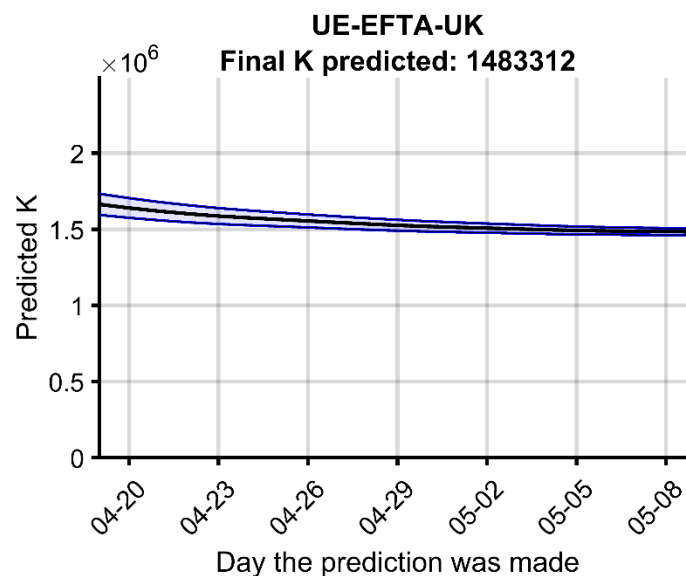
Long-term predictions

Long-term predictions, evaluated with the **whole historical series**. See figure in the next page. Up-left: Predictions of maximum incidences per country (total final expected attack rate per 10^5 inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current

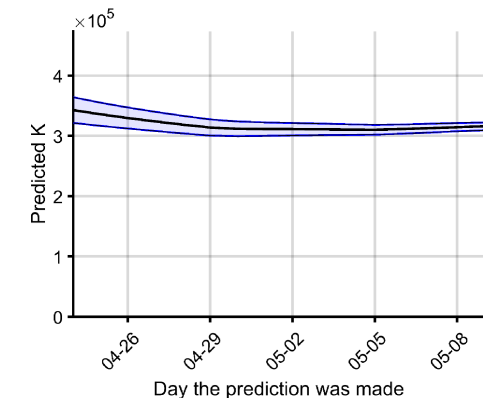
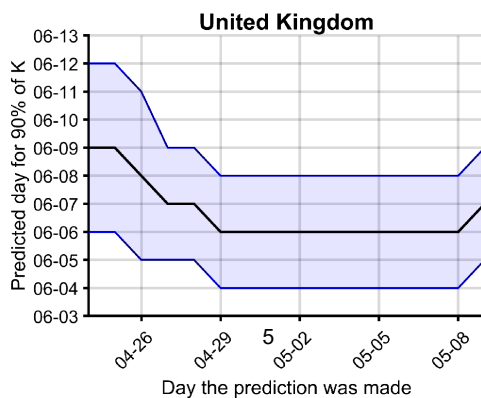
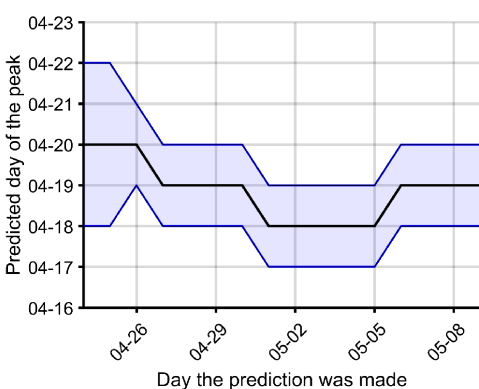
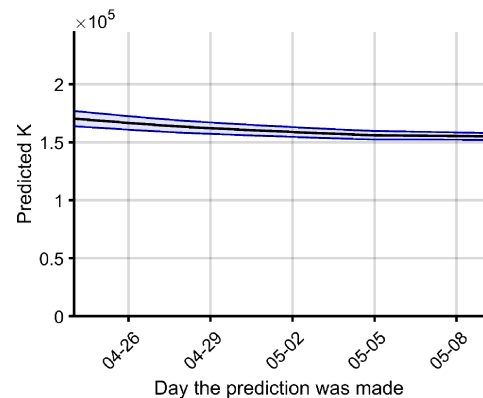
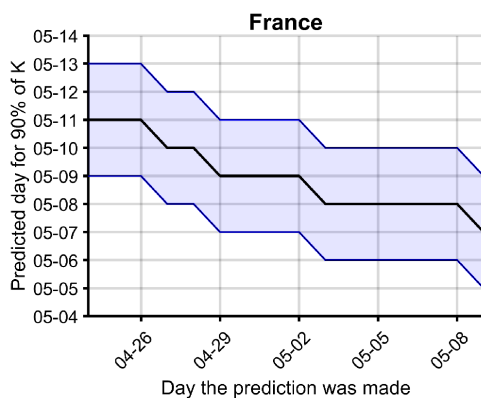
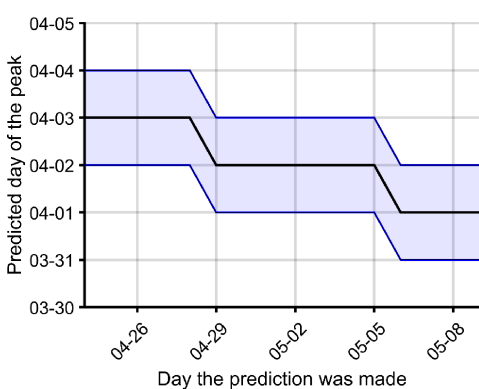
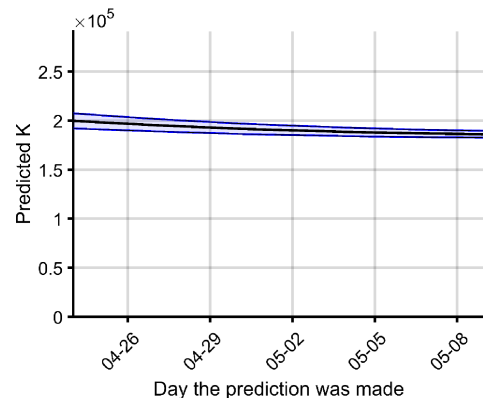
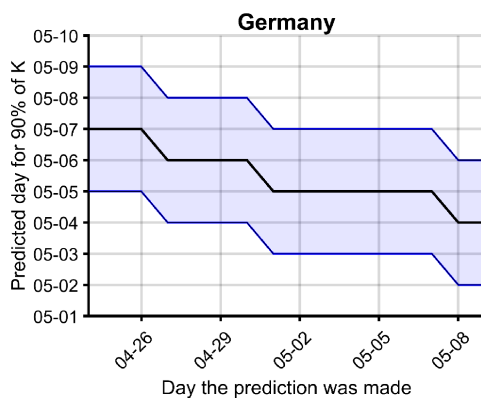
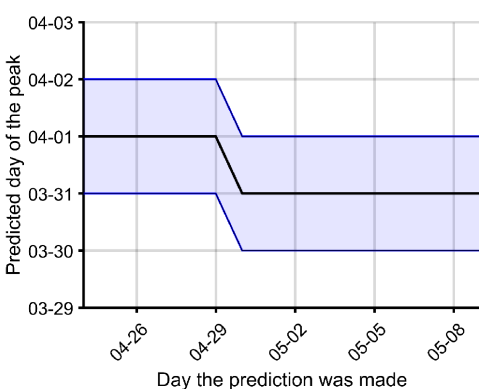
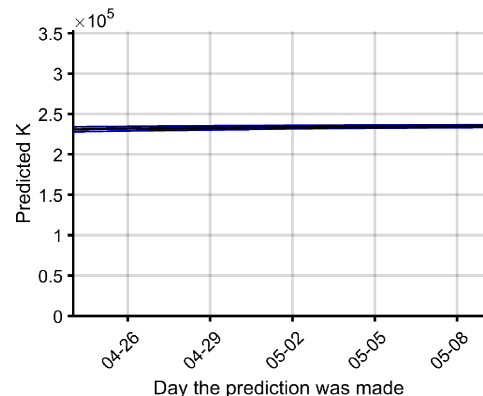
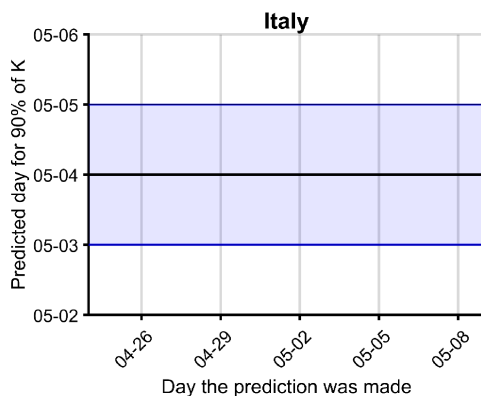
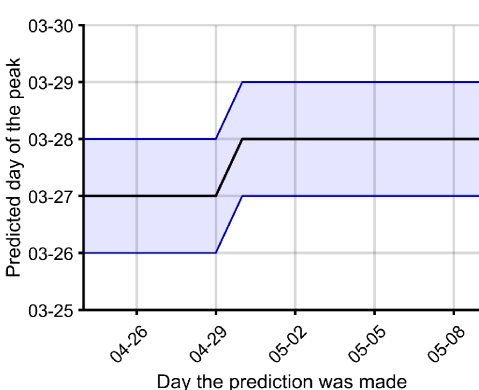
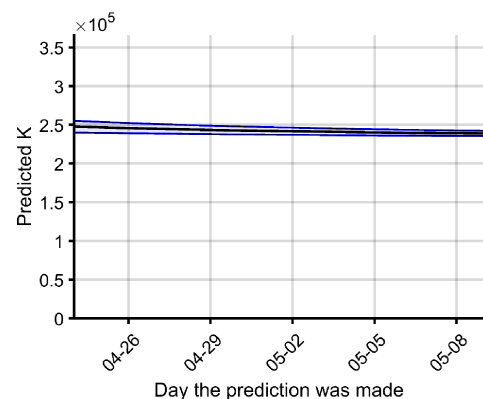
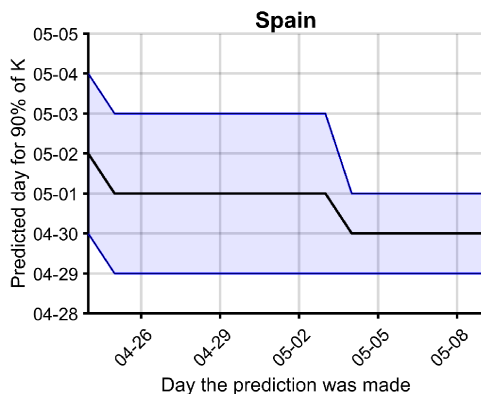
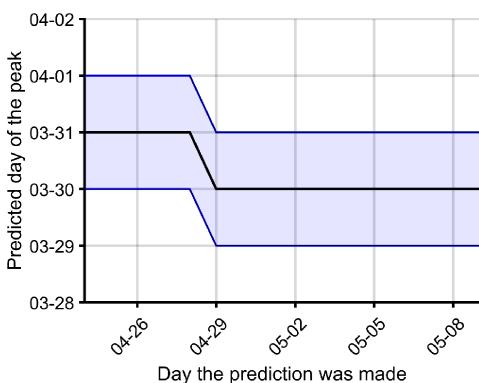
situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.



Final expected K for UE+EFTA+UK. Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown.



2020-05-09



Situation and trends per country

Maps. The map in the left shows cumulative incidence last 14 days (A_{14}). The map in the right shows smoothed spreading rate per country (ρ_7).

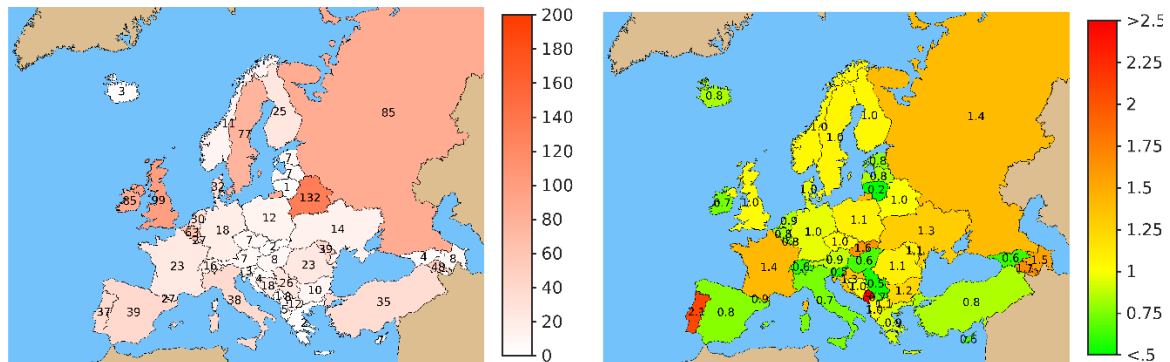


Table of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. EPG_{REP} and EPG_{EST} **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulative deaths	Mortality /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$\rho_7^{(1)}$	$EPG_{REP}^{(2)}$	$EPG_{EST}^{(3)}$
Spain	223,578	482.4	26,478	57.1	18,245	39.4	0.77	30	366
Italy	218,268	367.3	30,395	51.1	22,917	38.6	0.74	29	402
United Kingdom	215,260	324.0	31,587	47.5	66,883	100.7	1.02	103	1,629
Germany	169,218	206.6	7,395	9.0	15,043	18.4	0.95	17	83
France	138,854	214.5	26,310	40.7	14,740	22.8	1.41	32	656
Belgium	52,596	463.1	8,581	75.6	7,271	64.0	0.82	52	898
Netherlands	42,382	249.5	5,422	31.9	5,192	30.6	0.85	26	344
Switzerland	30,168	352.0	1,531	17.9	1,357	15.8	0.59	9	49
Portugal	27,406	264.2	1,126	10.9	3,723	35.9	2.10	75	350
Sweden	25,921	263.5	3,220	32.7	7,744	78.7	1.05	83	1,219
Ireland	22,760	481.6	1,446	30.6	4,199	88.8	0.73	65	423
Austria	15,777	181.1	615	7.1	643	7.4	0.88	7	26
Poland	15,651	40.9	785	2.1	4,378	11.5	1.08	12	75
Romania	15,131	76.5	926	4.7	4,496	22.7	1.09	25	177
Denmark	10,319	180.7	526	9.2	1,874	32.8	0.96	31	171
Czech Republic	8,095	76.3	276	2.6	743	7.0	1.01	7	26
Norway	8,069	150.3	213	4.0	602	11.2	1.04	12	32
Finland	5,880	106.9	265	4.8	1,405	25.5	1.04	26	139
Luxembourg	3,877	673.1	101	17.5	166	28.8	0.76	22	55
Hungary	3,263	33.5	413	4.2	763	7.8	0.64	5	71
Greece	2,710	24.2	151	1.4	204	1.8	0.92	2	11
Croatia	2,176	51.6	87	2.1	160	3.8	1.33	5	NA
Bulgaria	1,955	27.4	90	1.3	708	9.9	1.23	12	NA
Iceland	1,801	494.4	10	2.7	11	3.0	0.83	3	NA
Estonia	1,733	132.1	60	4.6	98	7.5	0.79	6	NA
Slovakia	1,455	26.7	26	0.5	82	1.5	1.63	2	NA
Slovenia	1,454	70.0	101	4.9	66	3.2	0.54	2	12
Lithuania	1,444	49.7	50	1.7	18	0.6	0.17	0	NA
Latvia	930	47.2	18	0.9	126	6.4	0.84	5	NA
Cyprus	892	76.2	21	1.8	82	7.0	0.62	4	NA
Malta	490	114.2	5	1.2	42	9.8	NA	NA	NA
Liechtenstein	83	215.3	1	2.6	0	0.0	NA	NA	NA

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2.0	200	2000
Best	Best	Best	Best	Best	Best	Best	0.0	0	0

⁽¹⁾ ρ_7 is the average of 7 consecutive ρ , but can still fluctuate. ⁽²⁾ EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by ρ_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by ρ_7 .

Time indicators by country

This table summarizes a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of $1/10^5$ inhabitants and an attack rate of $10/10^5$ inhabitants, and time interval between attack rates of 10 to 100 per 10^5 inhabitants (only for countries that have overtaken this threshold).

Countries	Days since the first 50 cases	Time interval between 1 and 10 cases / 10^5 inh. (days)	Time interval between 10 and 100 cases / 10^5 inh. (days)
Italy	78	11	16
France	72	10	20
Germany	72	12	17
Spain	70	7	12
United Kingdom	68	11	19
Norway	67	9	24
Switzerland	67	9	12
Netherlands	66	11	20
Sweden	66	10	28
Austria	65	10	14
Belgium	65	11	14
Greece	64	18	NA
Iceland	64	5	15
Denmark	62	4	30
Czech Republic	61	11	NA
Finland	60	12	46
Portugal	60	9	15
Slovenia	60	6	NA
Ireland	59	8	18
Romania	59	15	NA
Estonia	58	5	30
Poland	58	17	NA
Bulgaria	56	30	NA
Luxembourg	56	6	7
Slovakia	56	24	NA
Croatia	55	12	NA
Latvia	54	12	NA
Cyprus	53	12	NA
Hungary	53	20	NA
Malta	52	8	34
Lithuania	51	9	NA
Liechtenstein	46	9	11

Situation, trends and long-term predictions in Italian and Spanish regions

Italy

Country	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 ⁵ inh.	Cumulative deaths	Mortality / 10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate / 10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Lombardia	81.507	811,7	14.986	149,2	8.618	85,8	0,94	81	1.531
Piemonte	28.665	658,0	3.367	77,3	3.845	88,3	0,61	54	657
Emilia Romagna	26.796	600,9	3.845	86,2	2.346	52,6	0,59	31	458
Veneto	18.722	381,6	1.657	33,8	1.251	25,5	0,62	16	146
Toscana	9.774	262,1	942	25,3	627	16,8	0,62	10	110
Liguria	8.788	566,7	1.281	82,6	1.300	83,8	0,64	54	808
Lazio	7.165	121,9	557	9,5	856	14,6	0,82	12	97
Marche	6.533	428,3	960	62,9	422	27,7	0,92	26	392
Campania	4.588	79,1	391	6,7	257	4,4	0,78	3	30
Puglia	4.313	107,0	448	11,1	365	9,1	1,00	9	100
Trento	4.295	400,5	441	41,1	401	37,4	0,33	13	251
Sicilia	3.327	66,5	256	5,1	272	5,4	0,59	3	25
Friuli Venezia Giulia	3.130	257,6	310	25,5	213	17,5	0,63	11	105
Abruzzo	3.103	236,6	359	27,4	244	18,6	0,97	18	216
Bolzano	2.569	2.391,2	290	269,9	88	81,9	0,94	77	180
Umbria	1.411	160,0	71	8,0	43	4,9	1,67	8	NA
Sardegna	1.340	81,7	120	7,3	60	3,7	1,50	5	53
Valle d'Aosta	1.157	921,1	139	110,7	51	40,6	0,57	23	279
Calabria	1.132	58,1	91	4,7	43	2,2	0,80	2	NA
Basilicata	385	68,4	27	4,8	19	3,4	NA	NA	NA
Molise	370	121,1	22	7,2	74	24,2	NA	NA	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200
Best	Best	Best	Best	Best	Best	Best	0,0	0

Spain

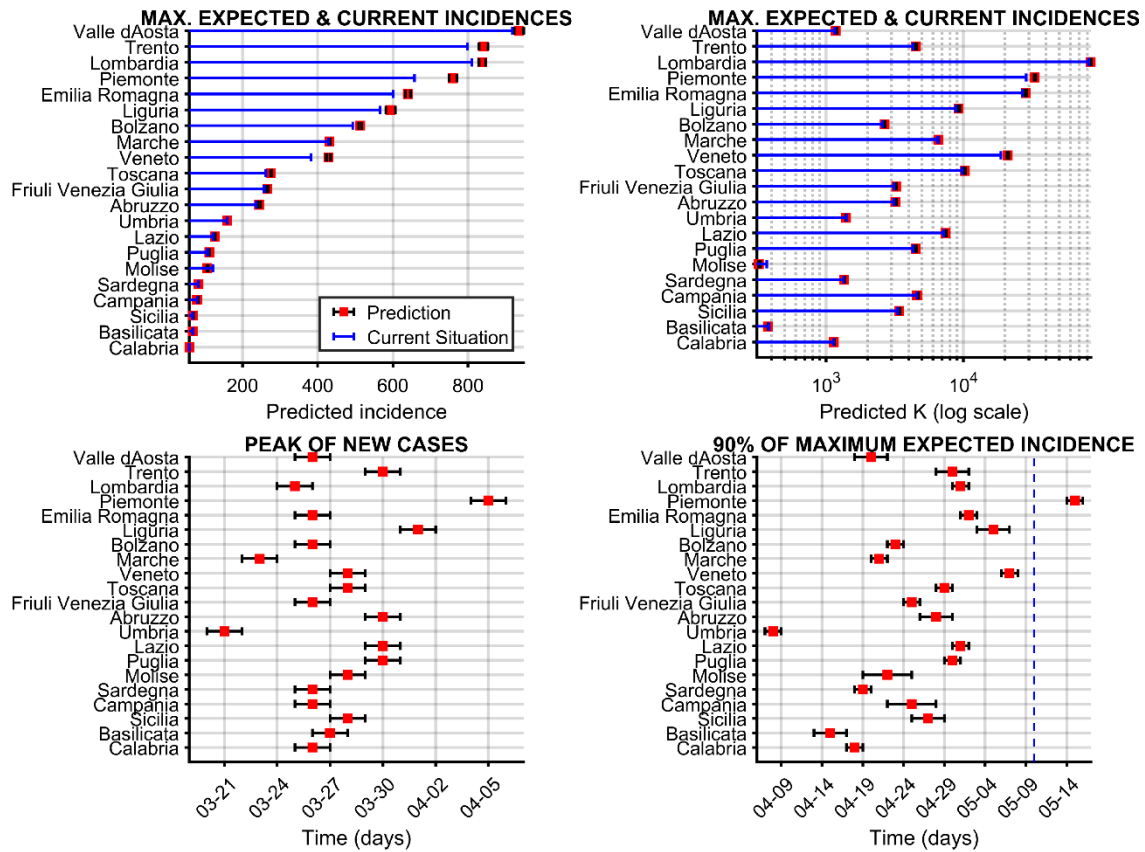
Autonomous regions	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 ⁵ inh.	Cumulated deaths	Mortality rate / 10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate / 10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Madrid	64.787	975,6	8.644	130,2	3.463	52,1	0,99	52	701
Catalunya	52.086	688,5	5.532	73,1	5.275	69,7	0,8	53	561
Castilla y Leon	17.917	744,0	1.897	78,8	1.695	70,4	0,74	52	570
Castilla-La Mancha	16.343	802,9	2.759	135,5	734	36,1	0,9	31	551
Euskadi	13.156	604,0	1.418	65,1	701	32,2	0,66	21	240
Andalucia	12.315	146,1	1.320	15,7	584	6,9	0,46	3	35
Comunitat Valenciana	10.713	215,4	1.323	26,6	553	11,1	1,03	12	152
Galicia	9.253	342,7	592	21,9	670	24,8	0,98	24	167
Aragon	5.316	402,5	824	62,4	361	27,3	0,77	21	343
Navarra	5.052	777,3	488	75,1	340	52,3	0,88	46	484
La Rioja	4.008	1.278,1	346	110,3	147	46,9	0,76	36	318
Extremadura	2.912	273,3	480	45,1	176	16,5	0,87	14	245
Asturias	2.343	229,2	295	28,9	81	7,9	2,03	16	211
Canarias	2.258	102,3	148	6,7	91	4,1	0,79	3	22
Cantabria	2.244	385,8	201	34,6	161	27,7	0,98	27	247
Baleares	1.950	164,2	209	17,6	96	8,1	1,09	9	103
Murcia	1.508	101,4	139	9,3	34	2,3	1,01	2	23
Melilla	119	140,5	2	2,4	9	10,6	NA	NA	NA
Ceuta	110	129,7	4	4,7	10	11,8	NA	NA	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200
Best	Best	Best	Best	Best	Best	Best	0,0	0

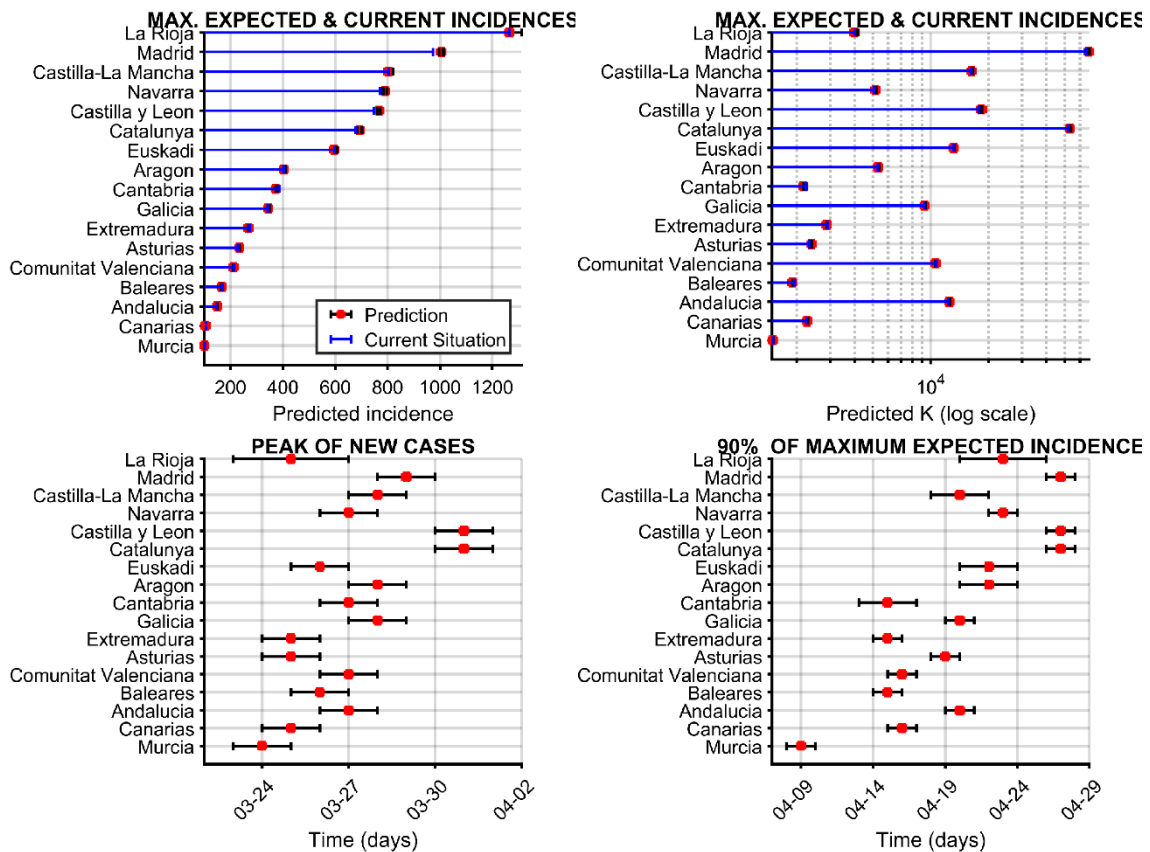
⁽¹⁾ Disclaimer: parameter ρ is very sensitive and experiments daily variations. ρ_7 is the average of 7 consecutive ρ , but can still fluctuate. ⁽²⁾ EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by ρ_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by ρ_7 .

Long-term predictions. These plots show long-term predictions of: new cases' peaks, final incidence value and approximate date when 90% of total final incidence will be reached. In all three cases we are dealing with the evaluation of global dynamics, which requires small changes in methodology: all data points be used instead of last 15 and with equal weight distribution among them. Blue dashed line indicates current timepoint. See details in Report from 11th April 2020.

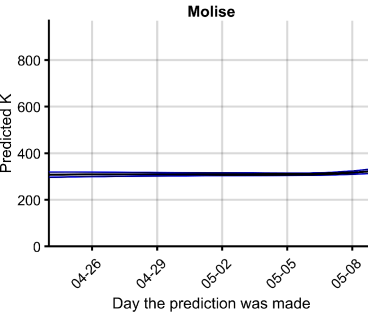
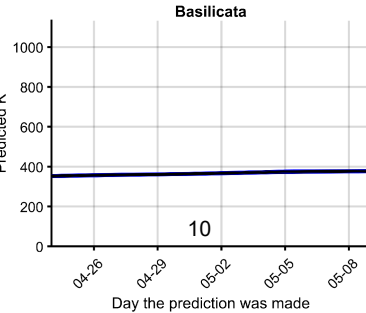
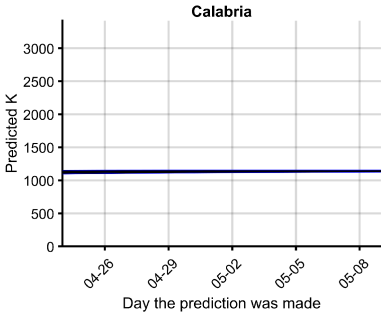
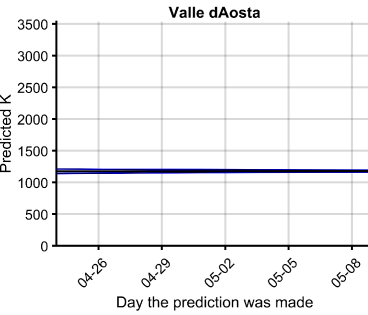
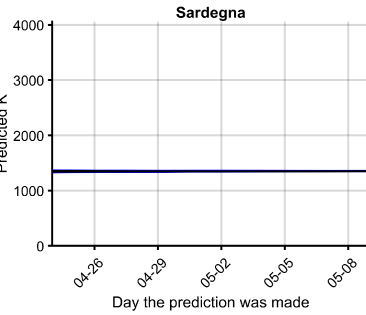
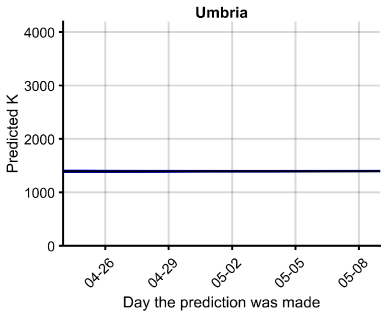
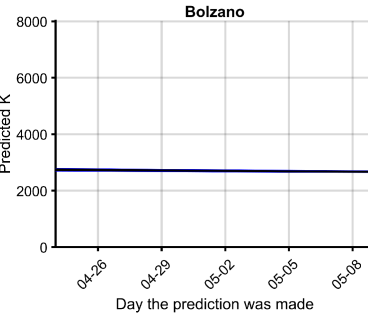
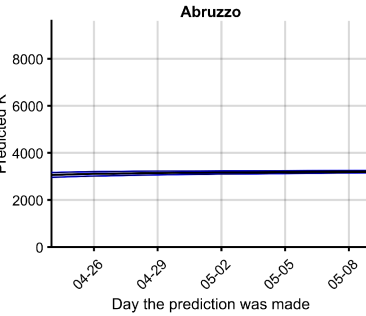
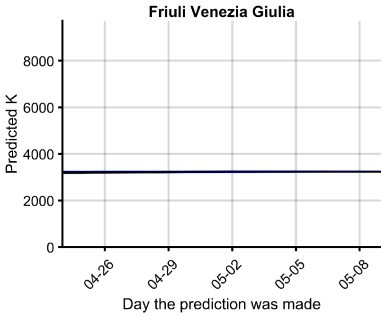
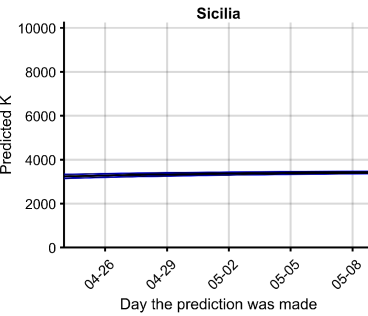
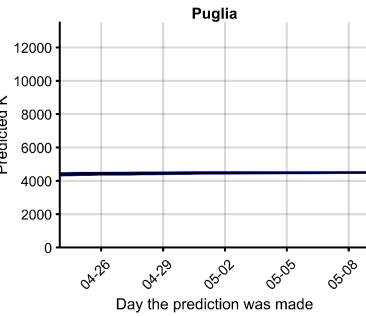
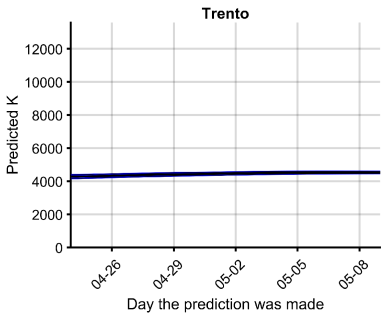
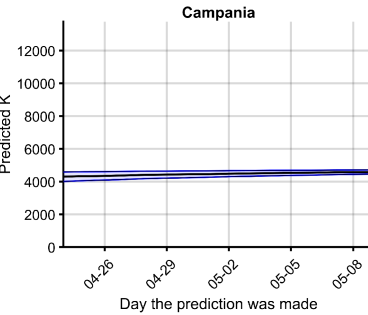
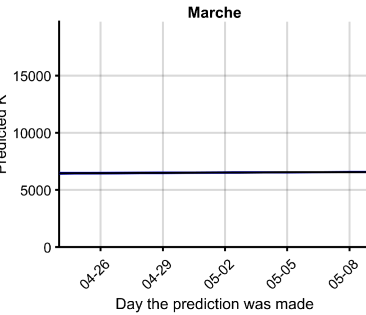
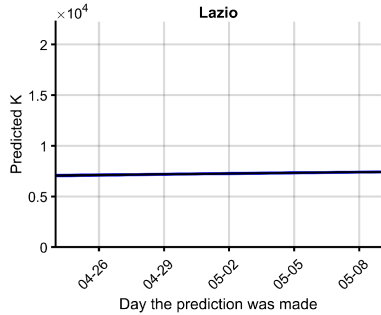
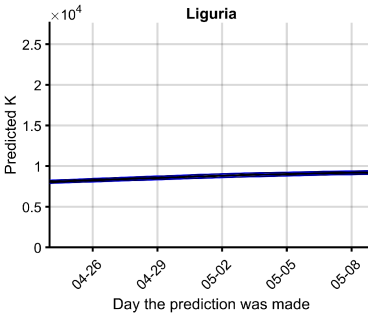
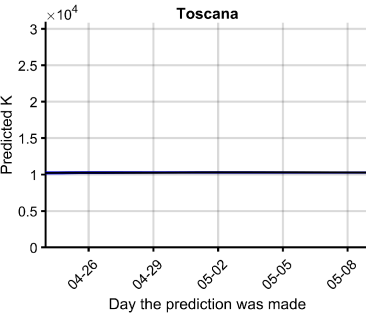
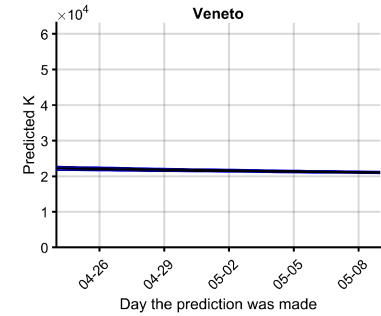
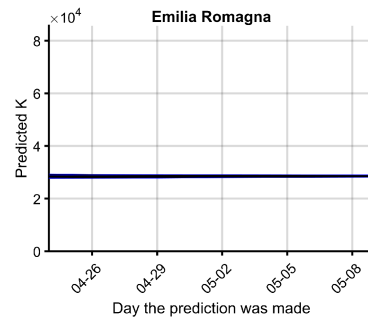
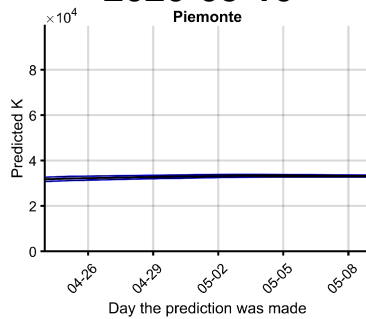
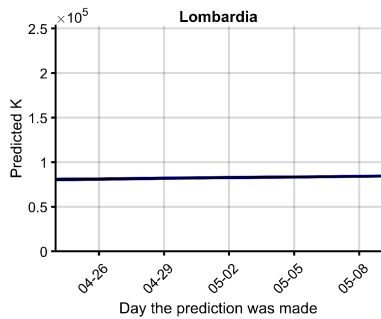
Italy



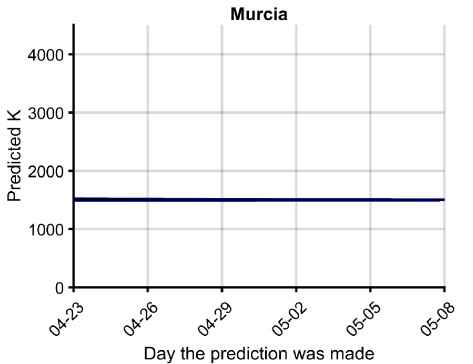
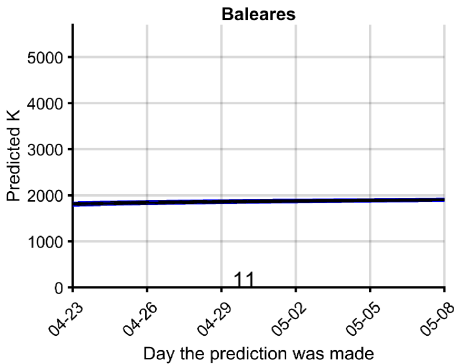
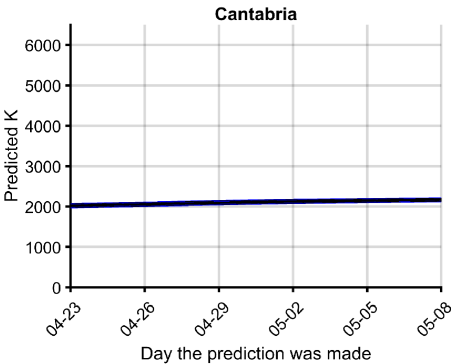
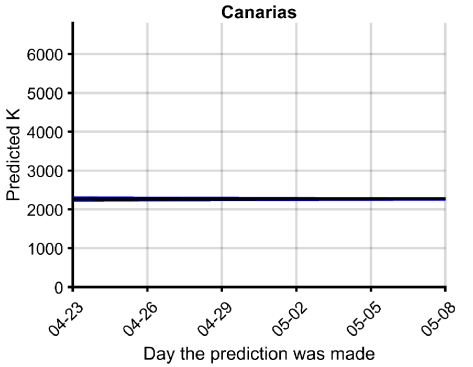
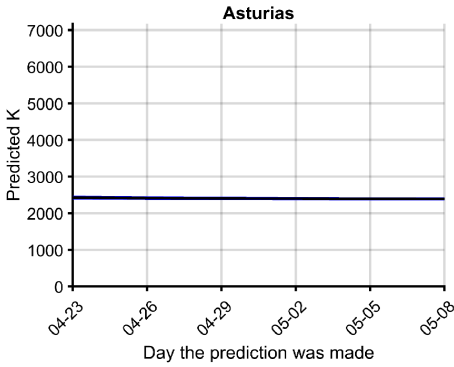
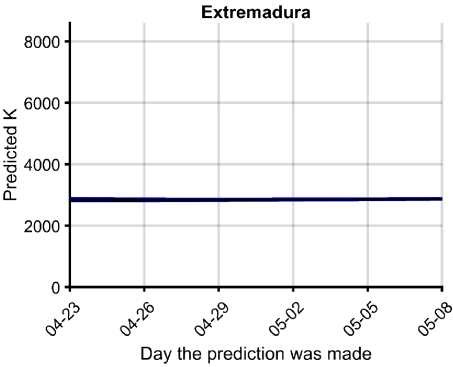
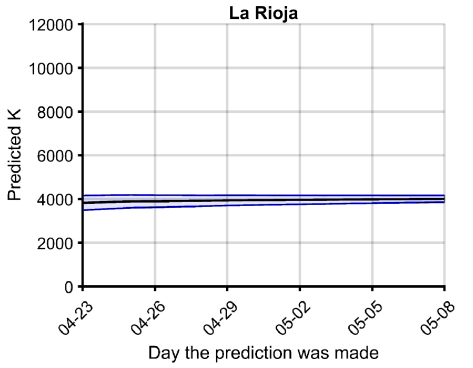
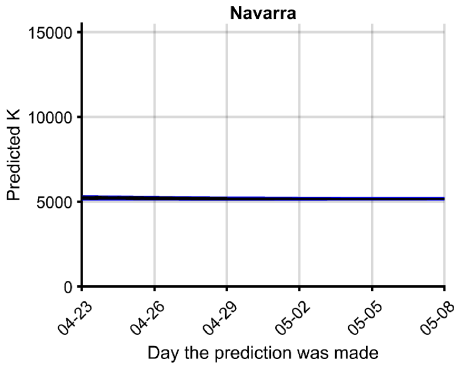
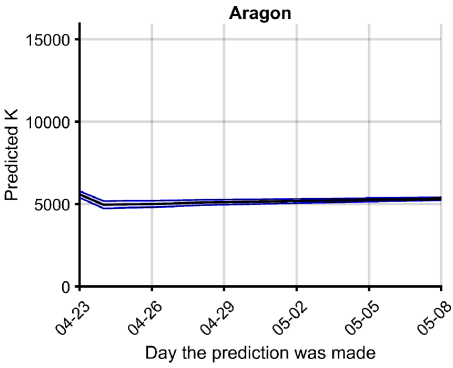
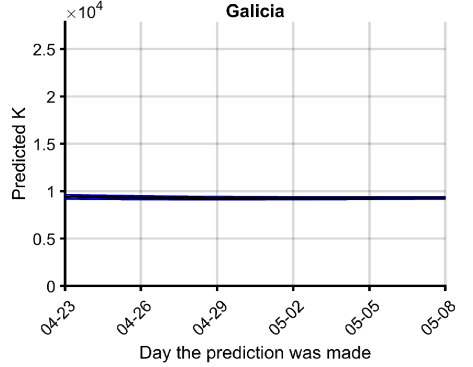
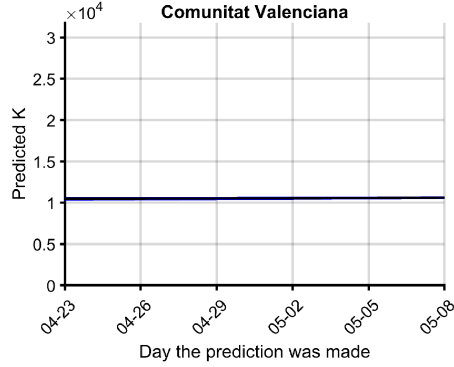
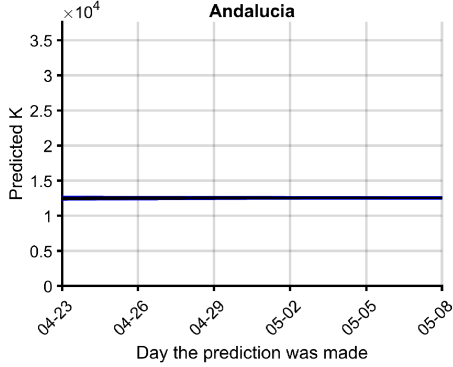
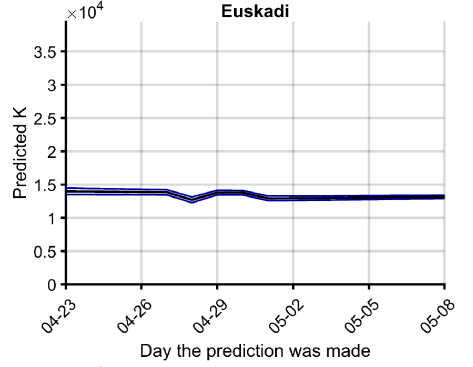
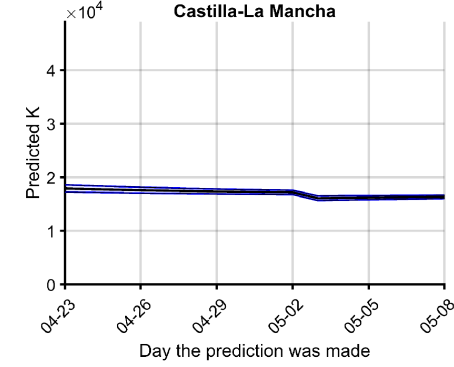
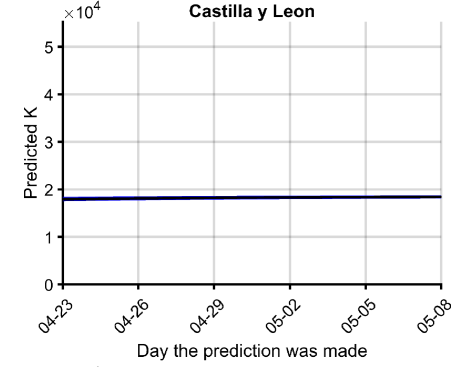
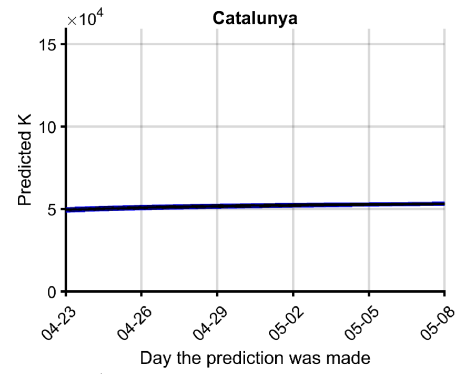
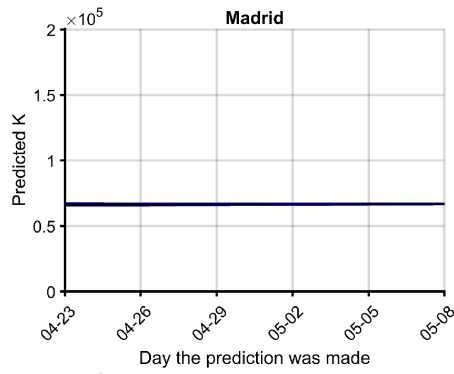
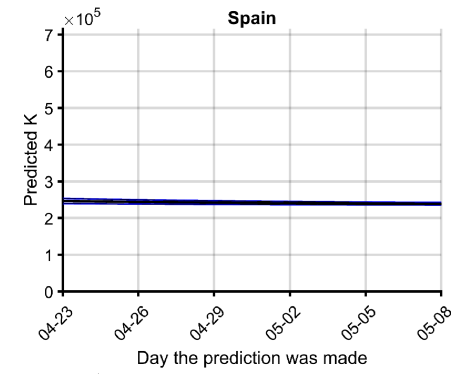
Spain



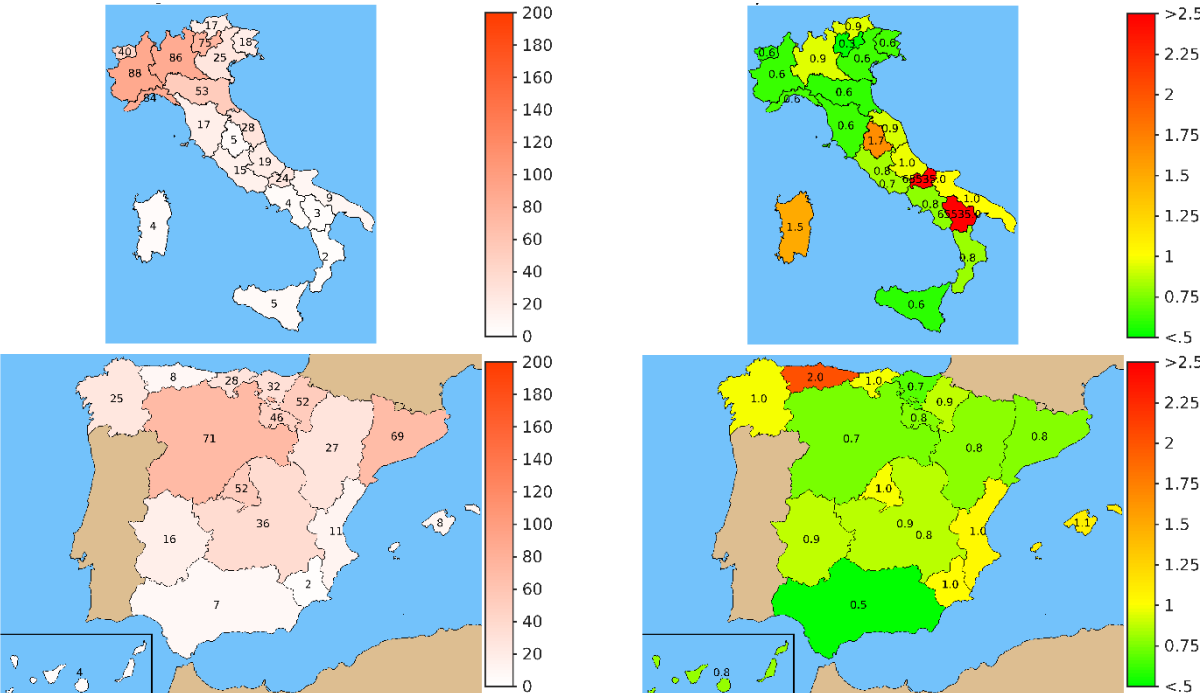
2020-05-10



2020-05-09



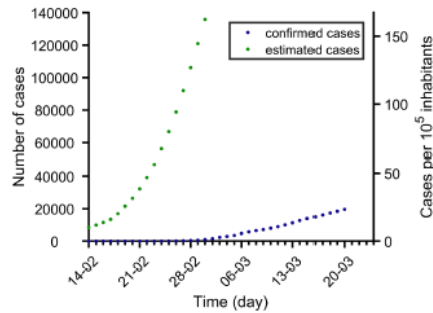
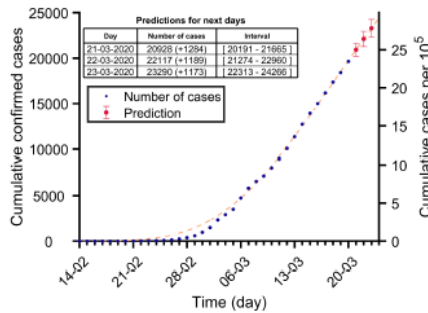
Maps. The maps in the left show cumulative incidence last 14 days (A_{14}). The maps in the right show smoothed spreading rate per country (ρ_7).



Legend: Countries' reports details

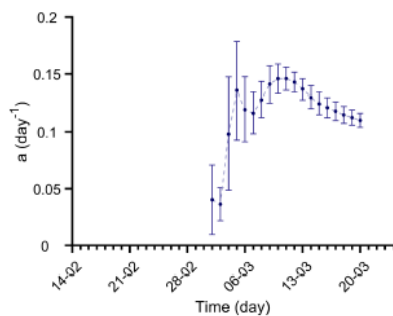
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence: $23/10^5$

Confirmed cases:
data (blue),
model fitted
(dashed line),
predictions (red
points and table)

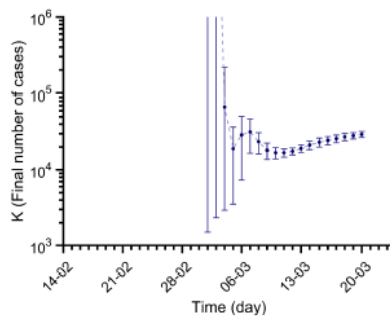


Estimated
cases using
death rate (see
Methods)

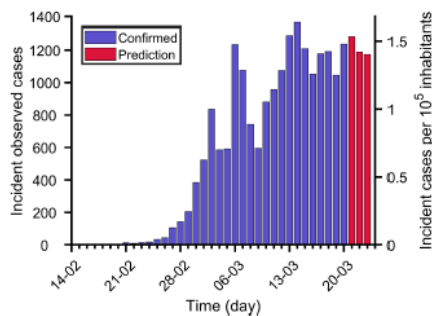
Fitted a value
using points
prior to each
date



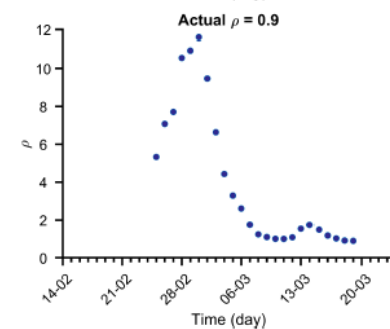
Fitted K value
using points
prior to each
date



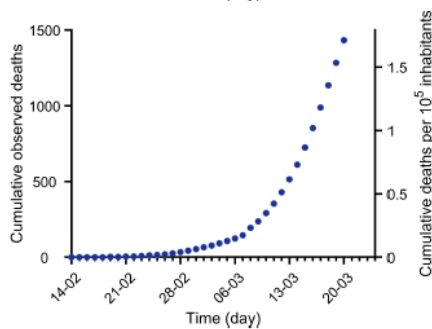
Reported
and
predicted
new cases



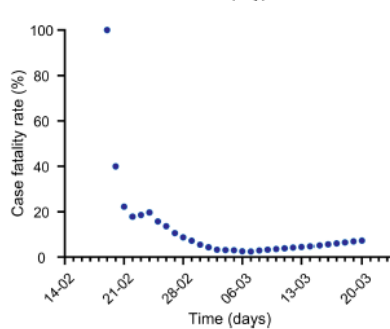
Evolution of ρ , a
parameter related
with Reproduction
number (see
Methods)



Reported
deaths

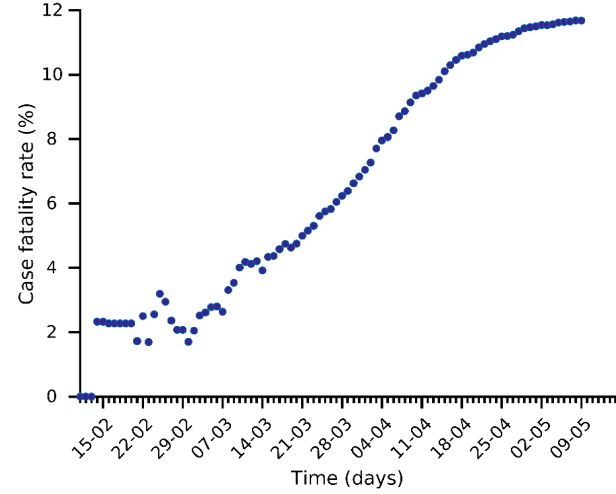
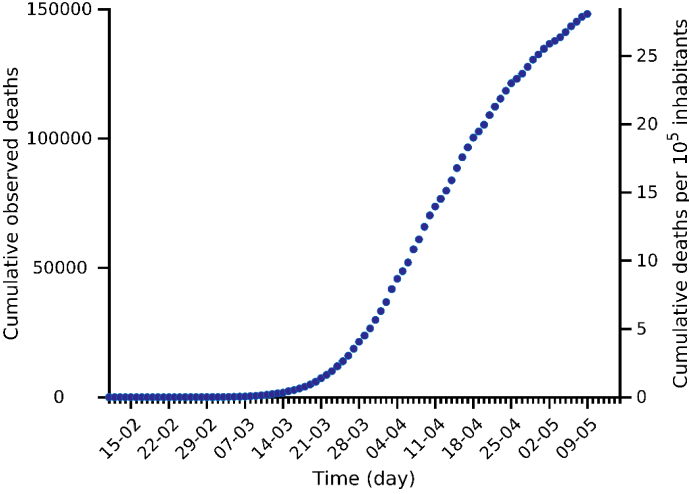
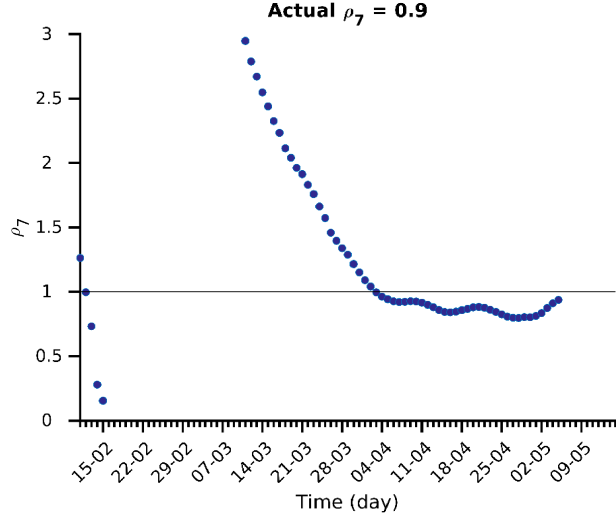
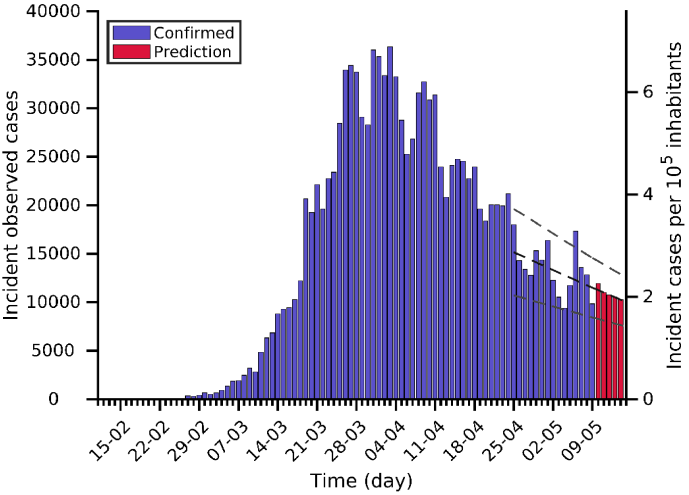
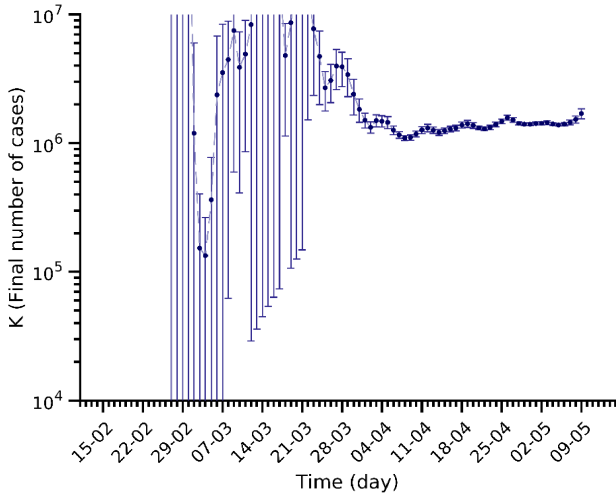
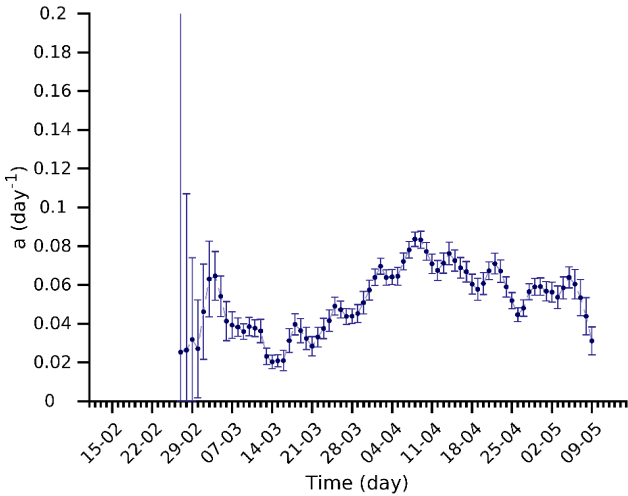
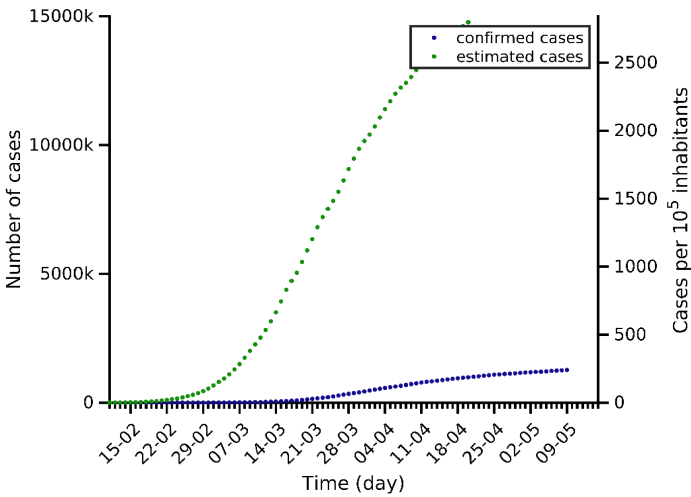
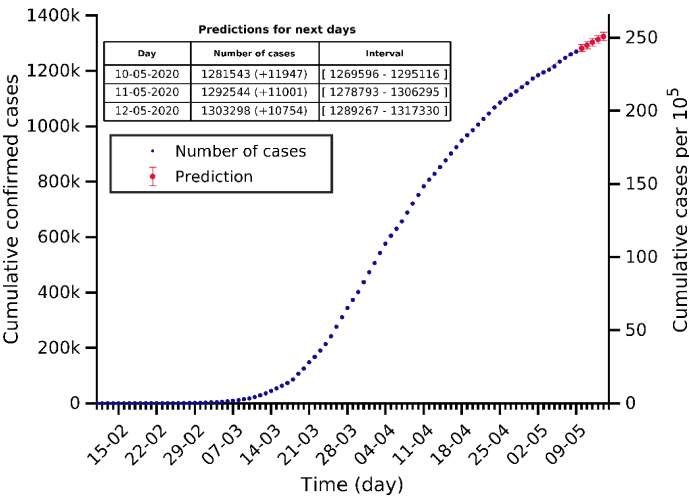


Deaths /
cumulated
reported cases

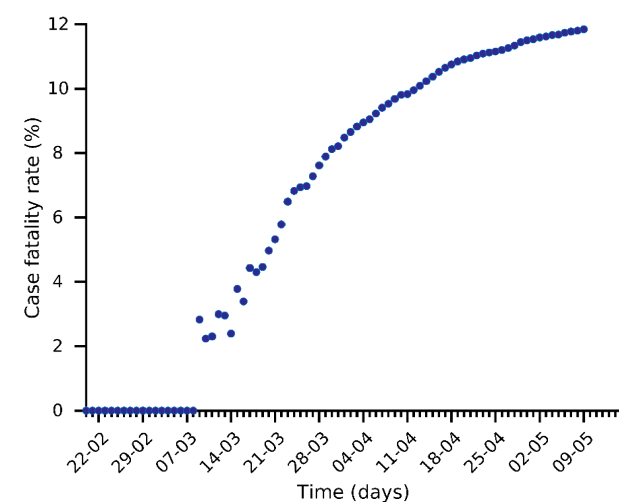
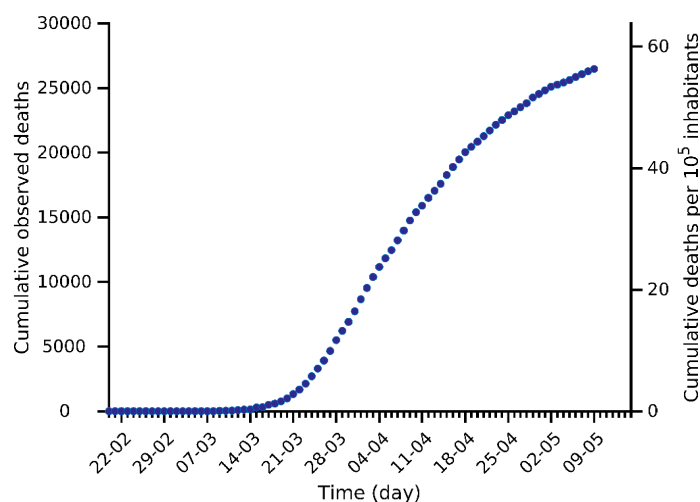
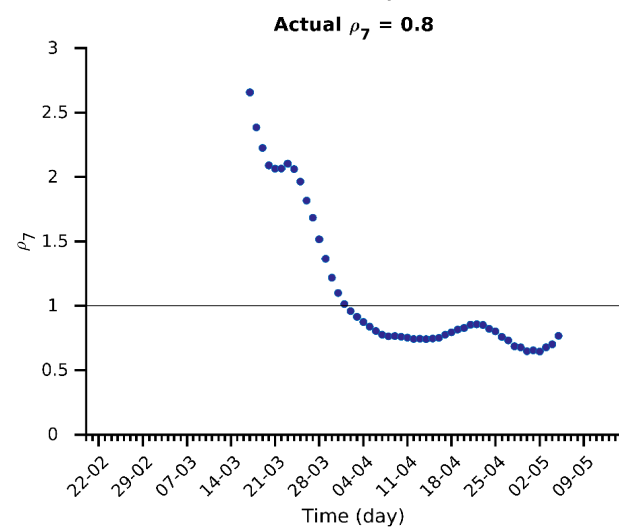
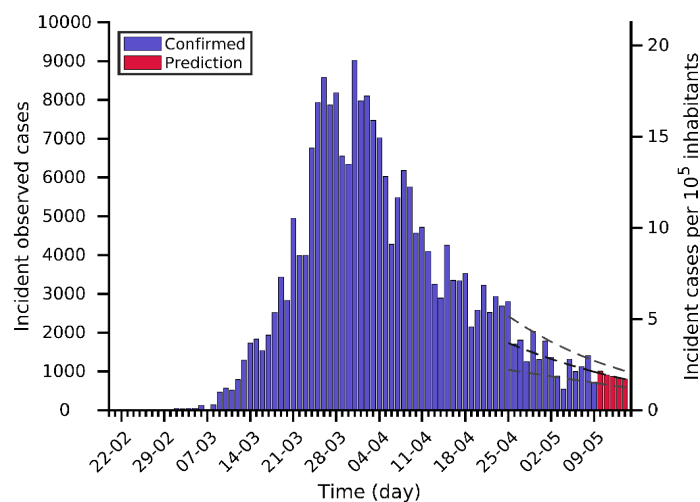
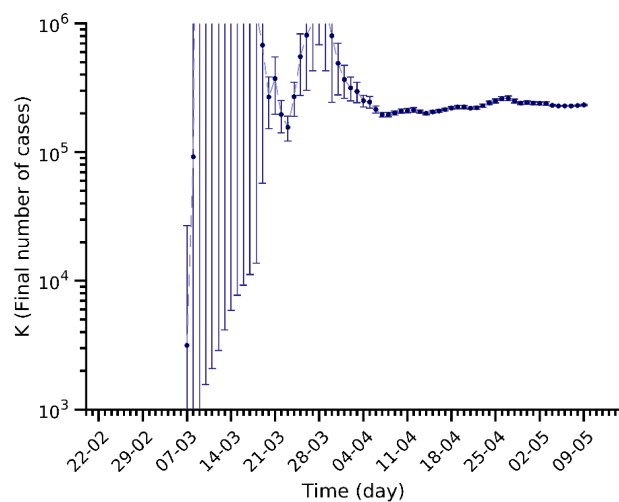
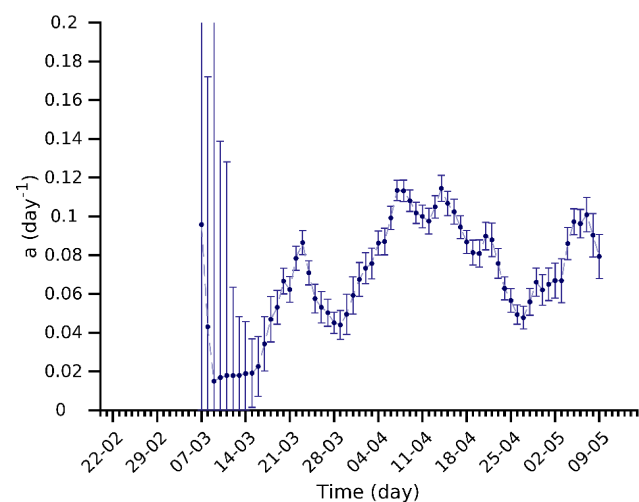
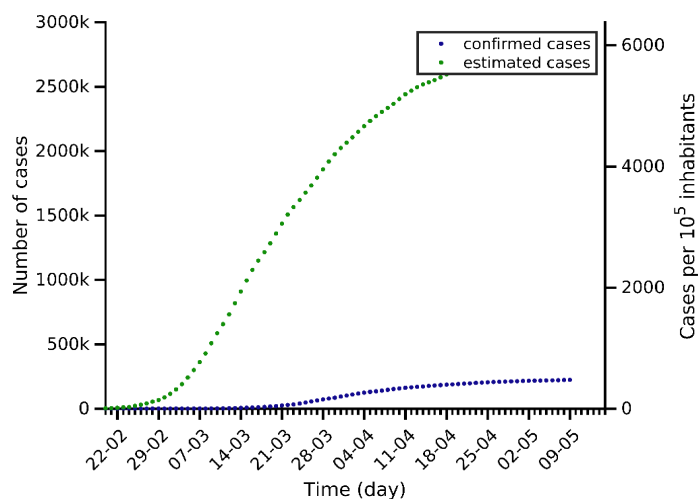
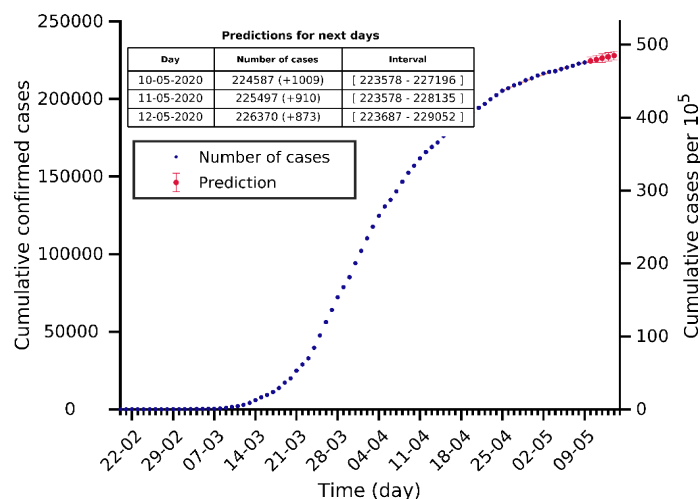


(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

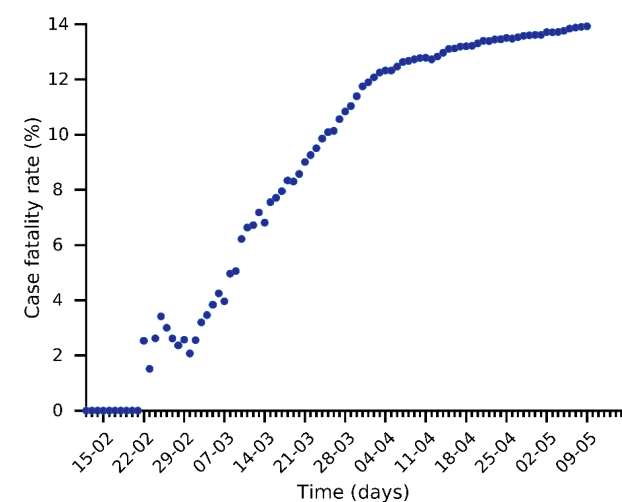
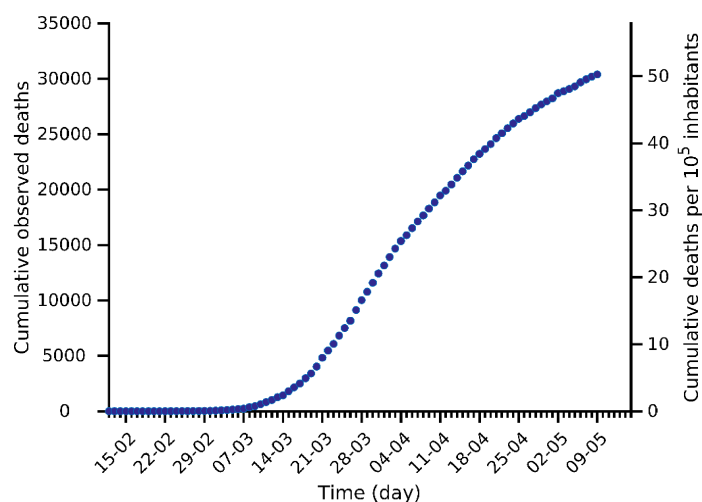
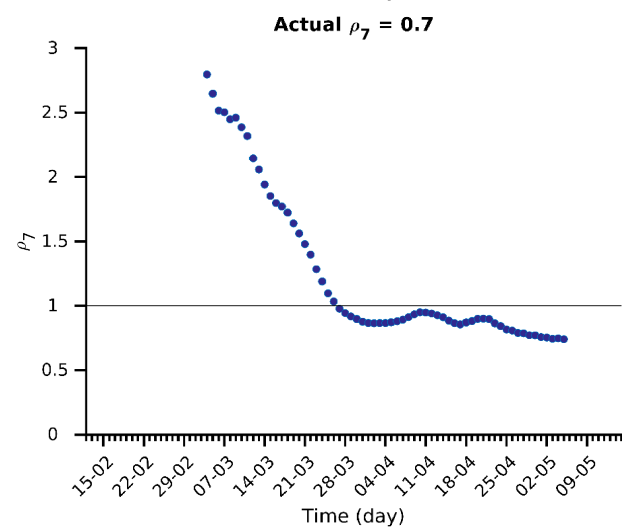
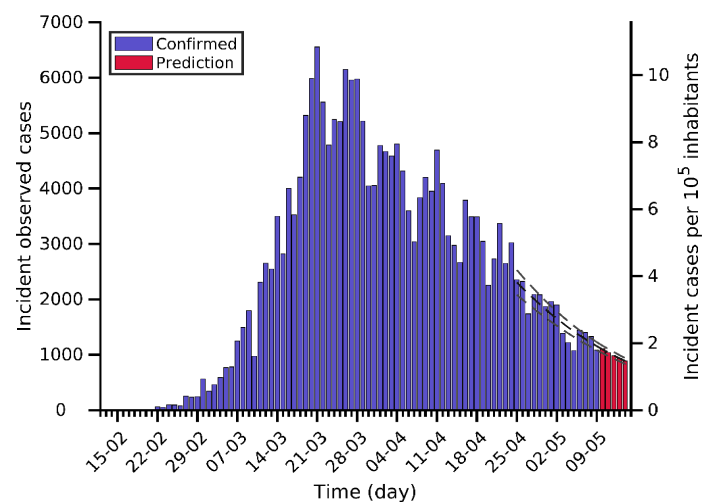
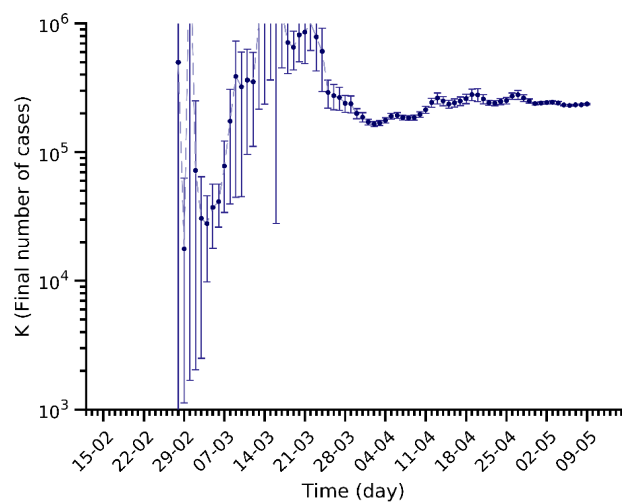
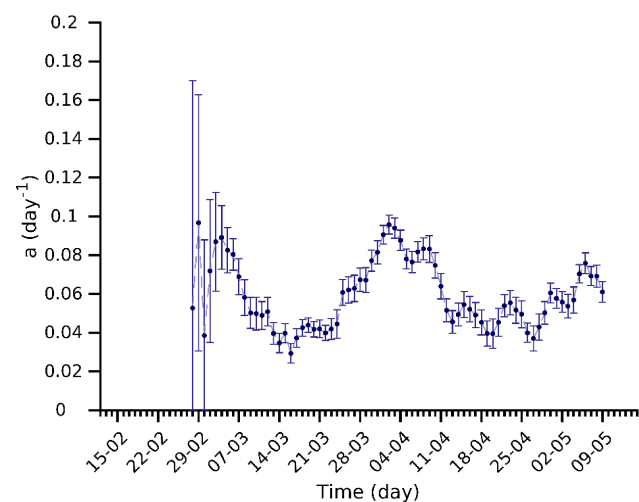
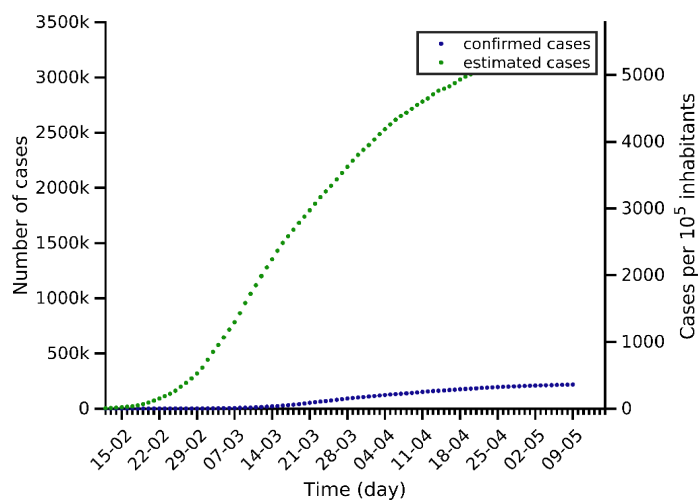
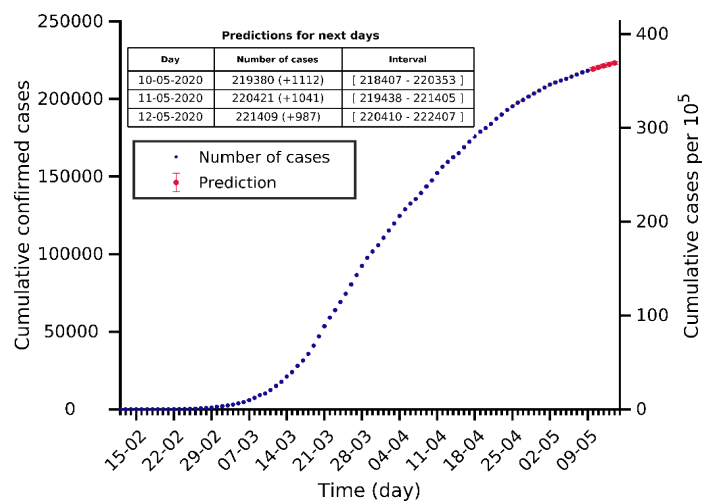
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>



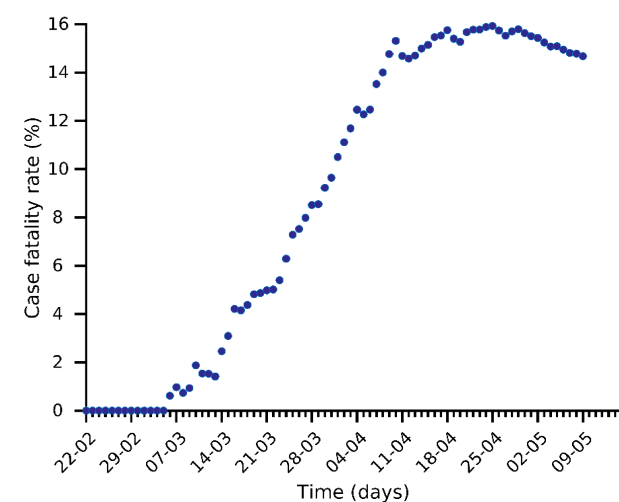
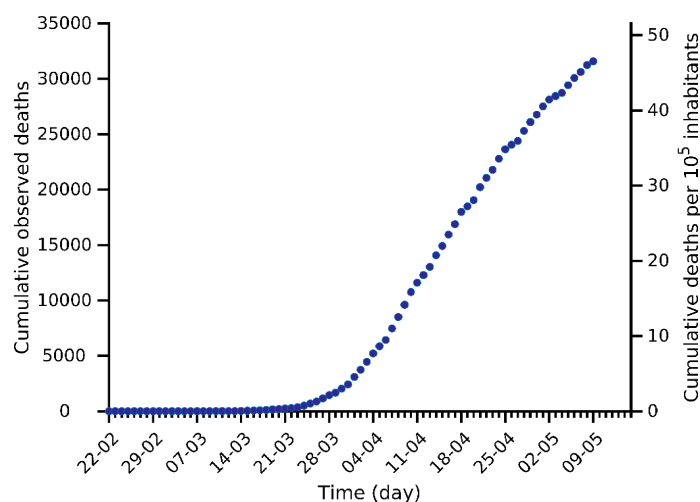
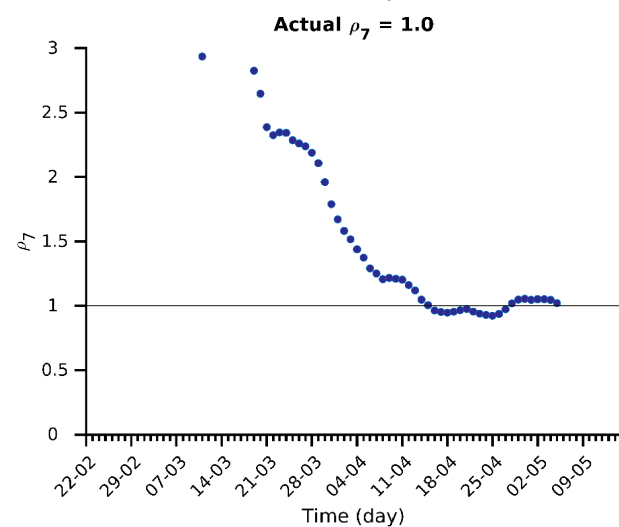
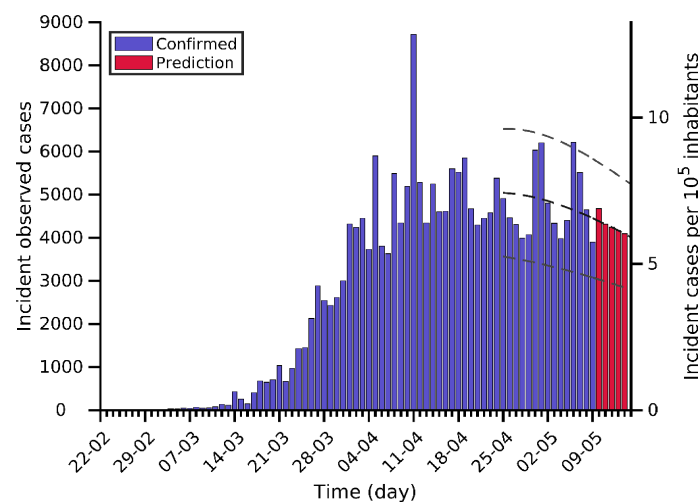
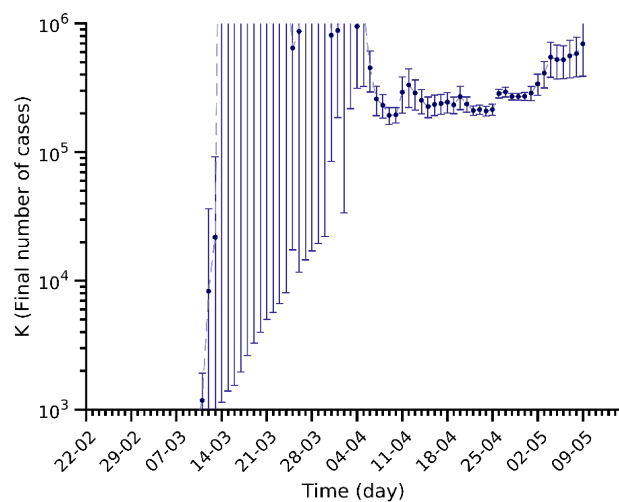
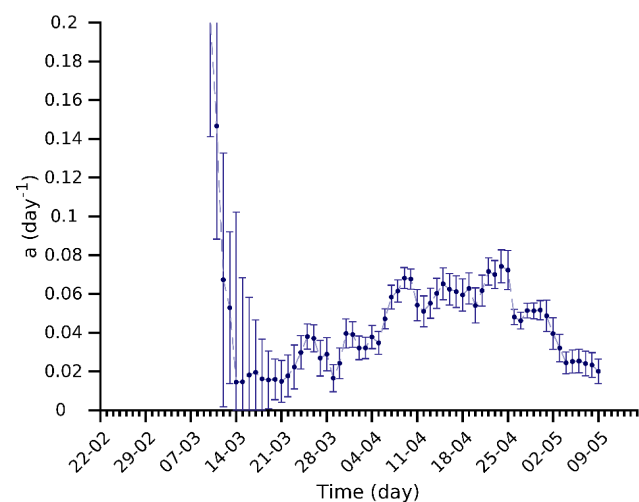
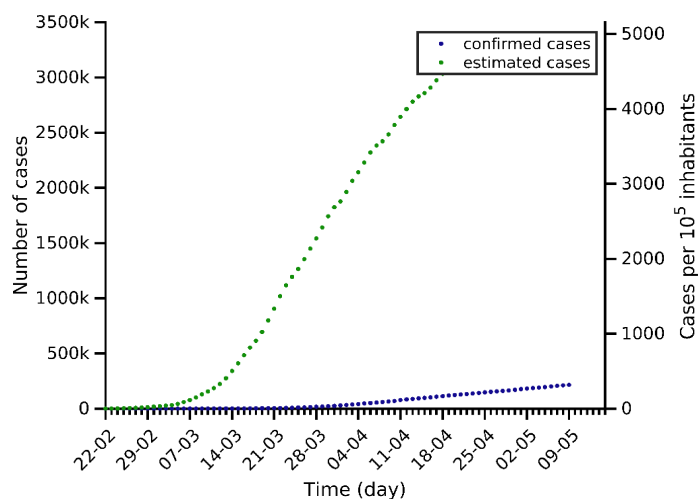
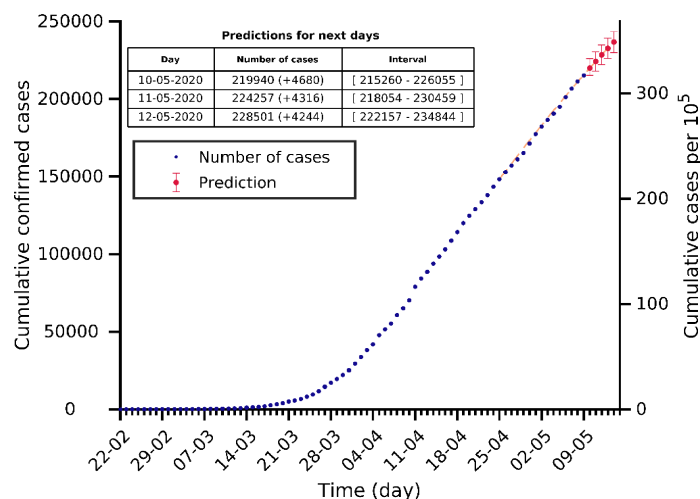
Spain 09-05-2020. Population: 47.0M. Current cumulated incidence: 475/10⁵



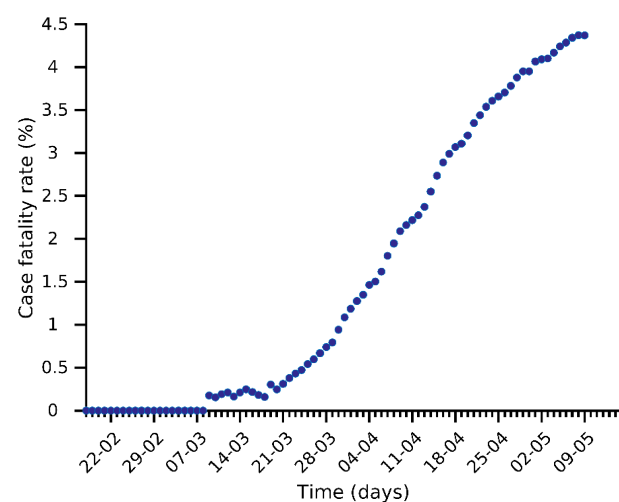
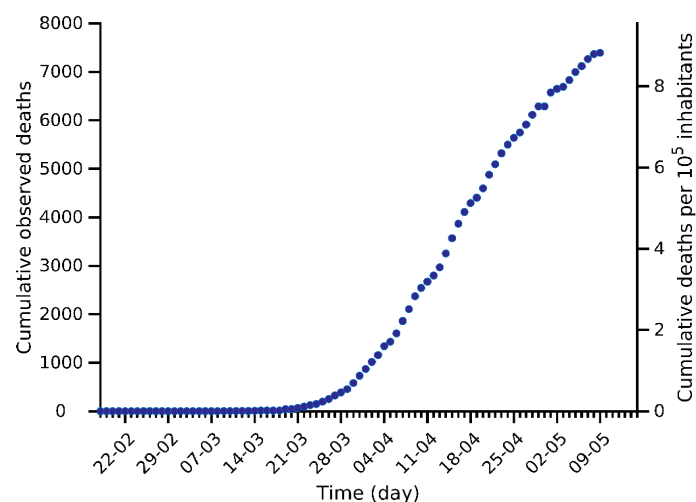
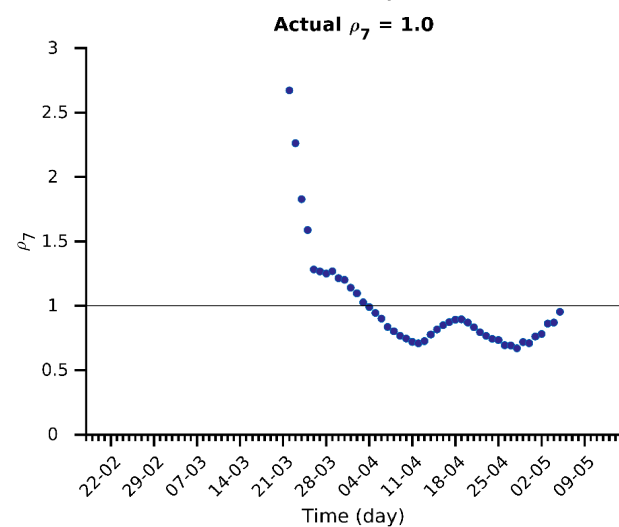
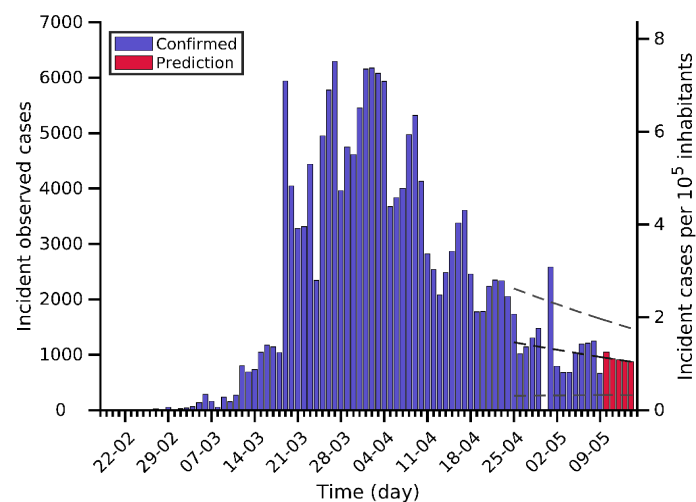
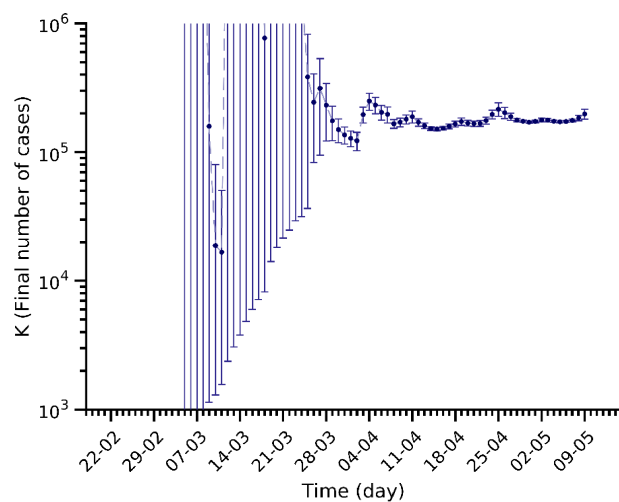
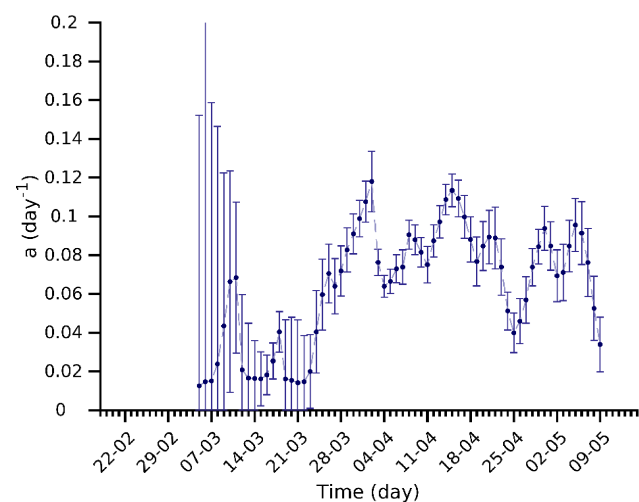
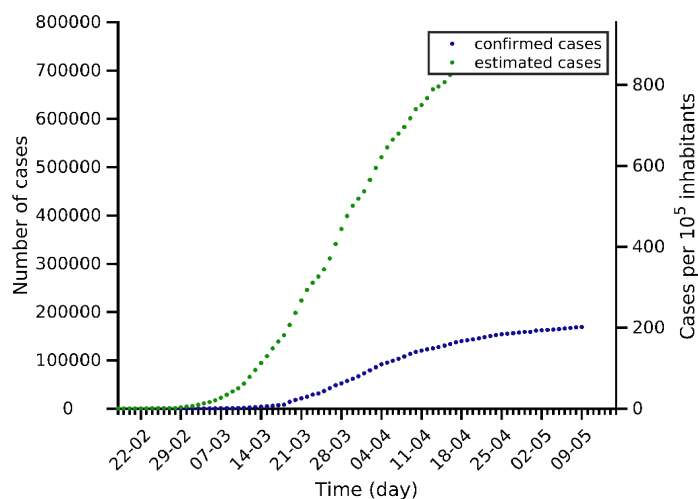
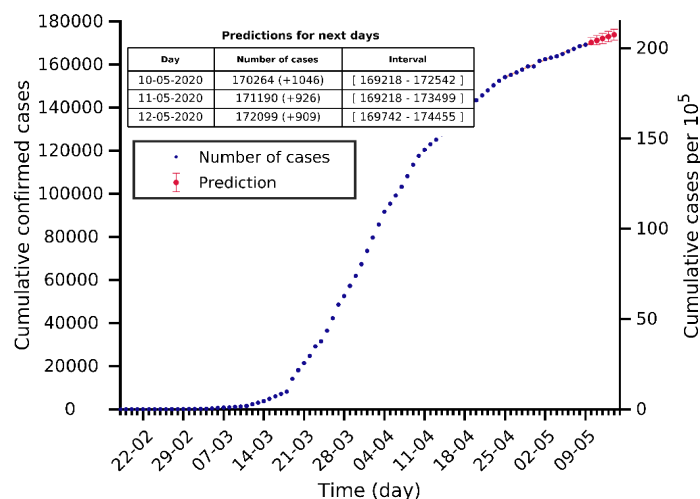
Italy 09-05-2020. Population: 60.5M. Current cumulated incidence: 361/10⁵



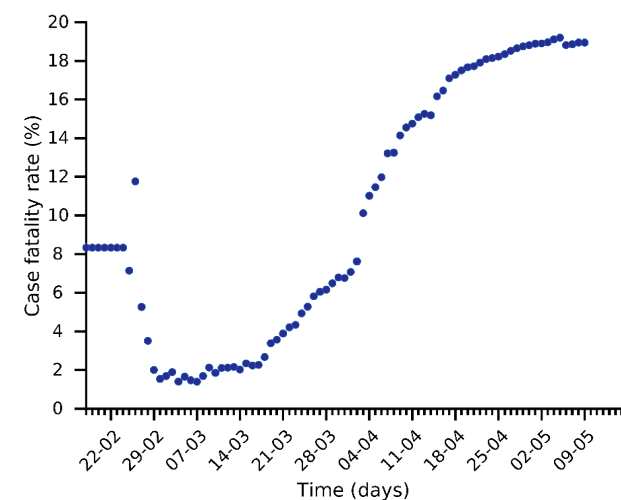
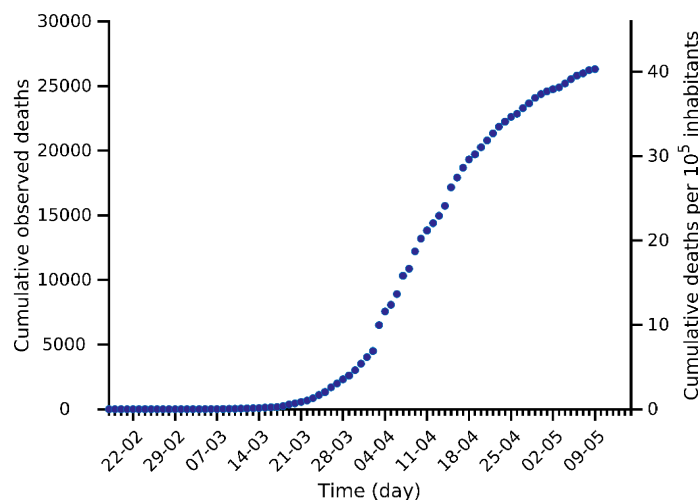
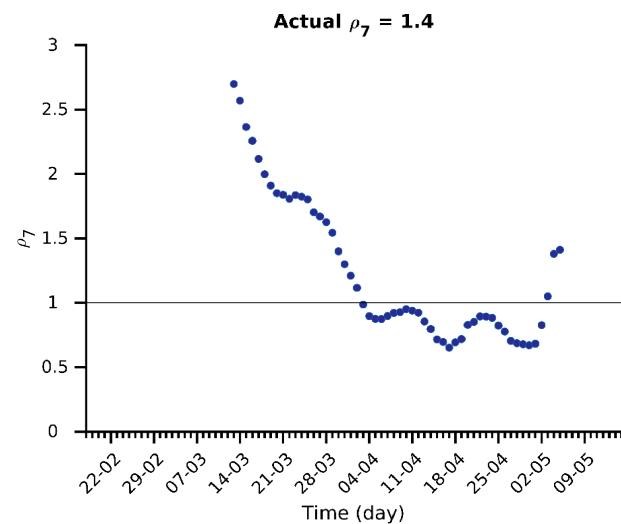
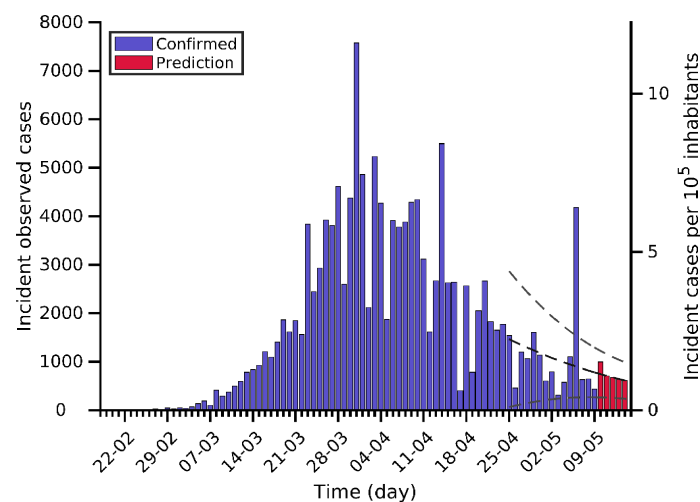
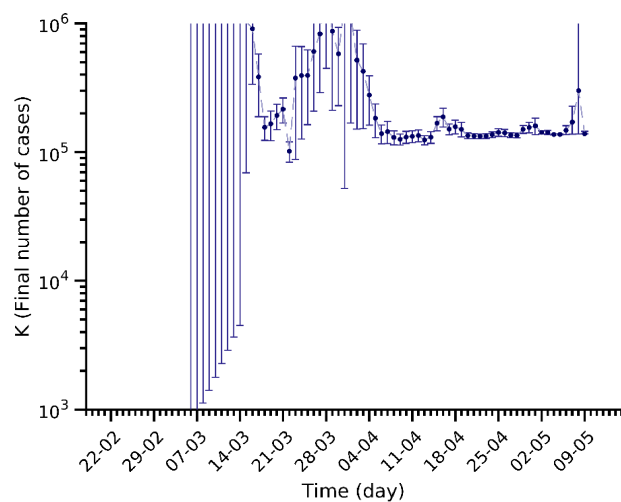
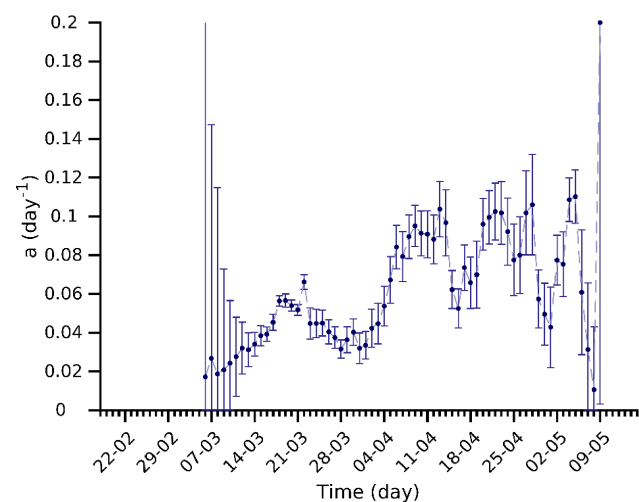
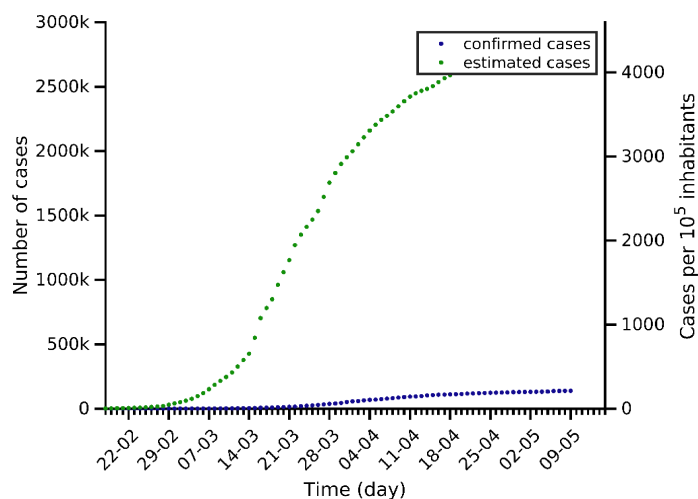
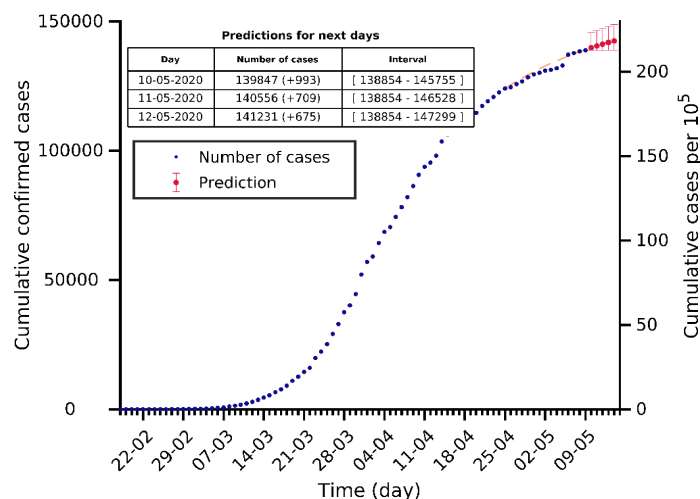
UK 09-05-2020. Population: 67.9M. Current cumulated incidence: 317/10⁵



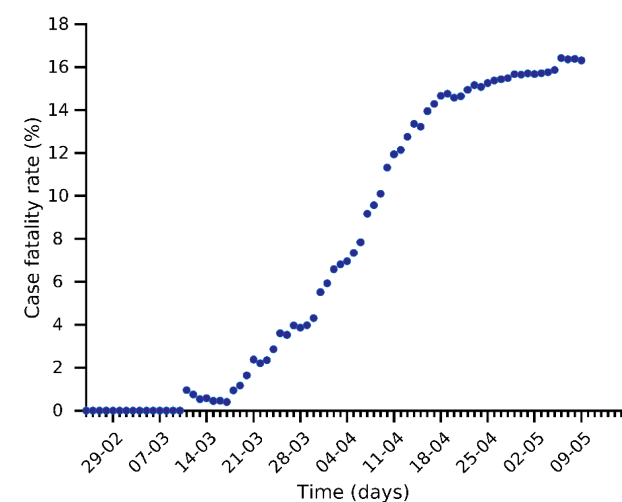
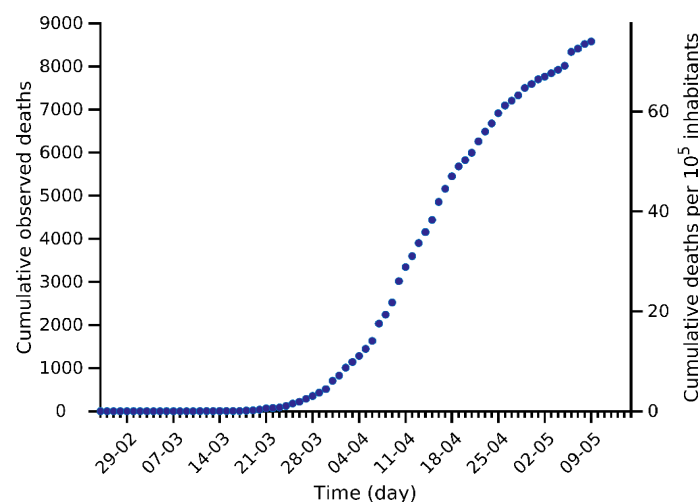
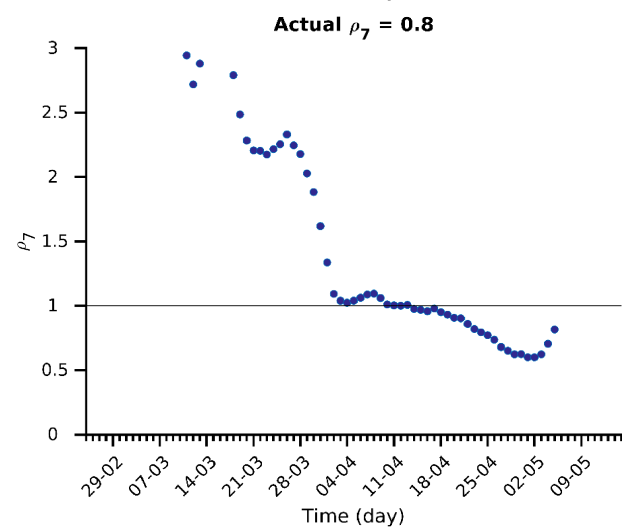
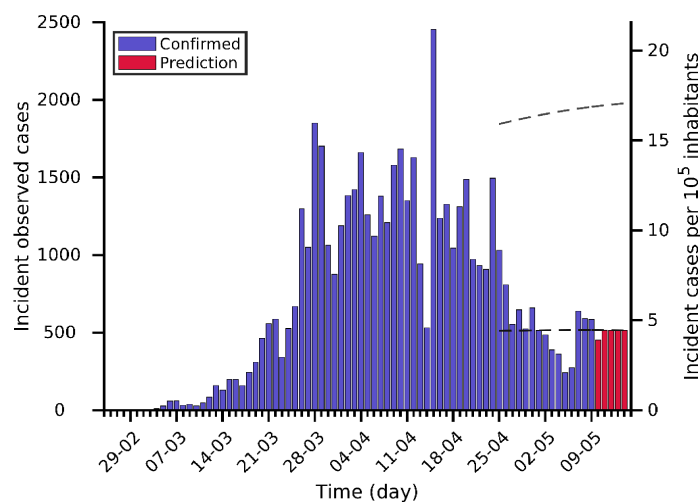
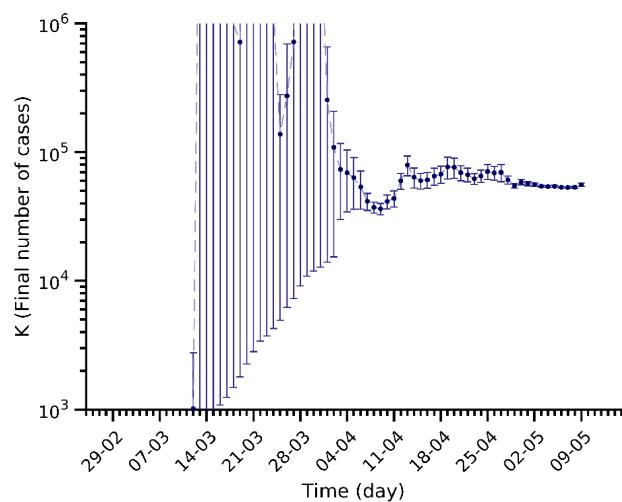
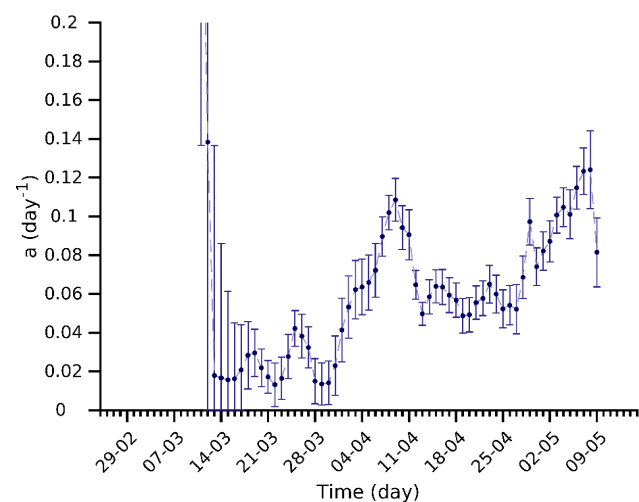
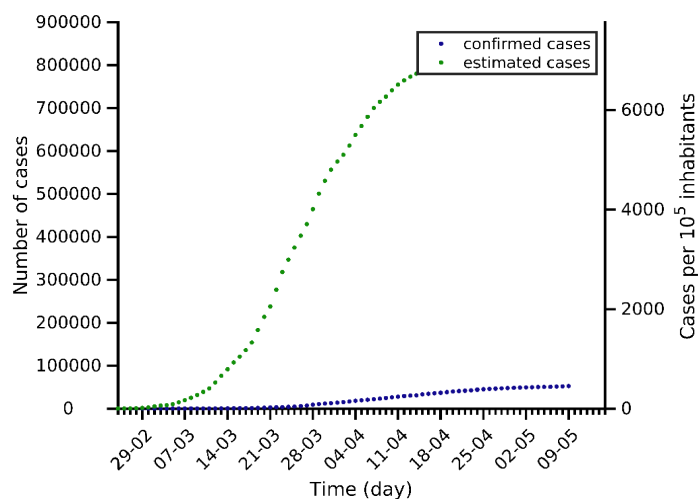
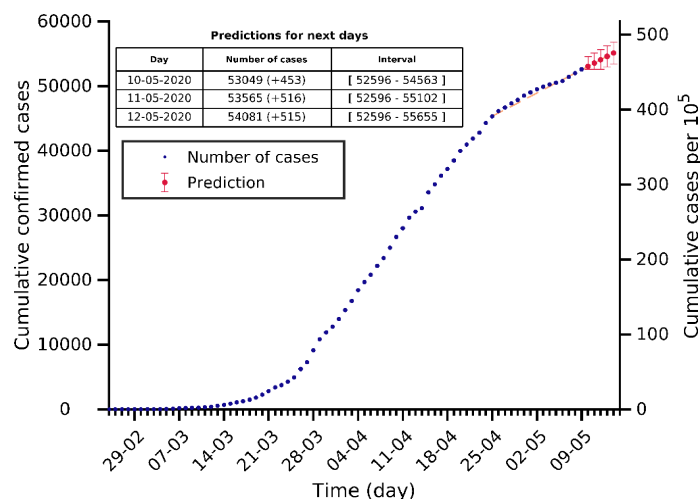
Germany 09-05-2020. Population: 83.8M. Current cumulated incidence: 202/10⁵



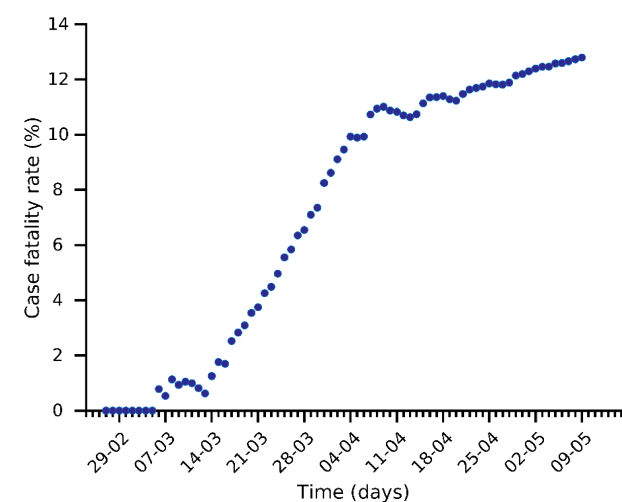
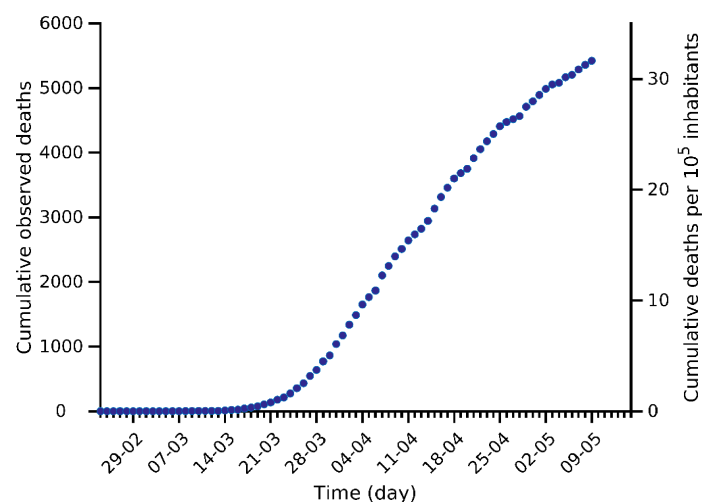
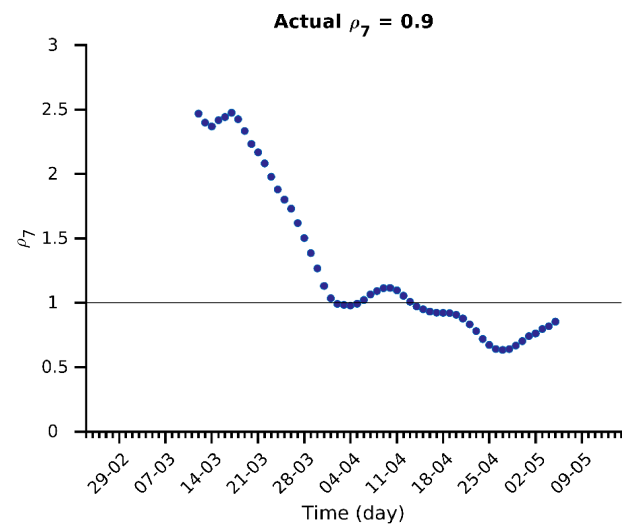
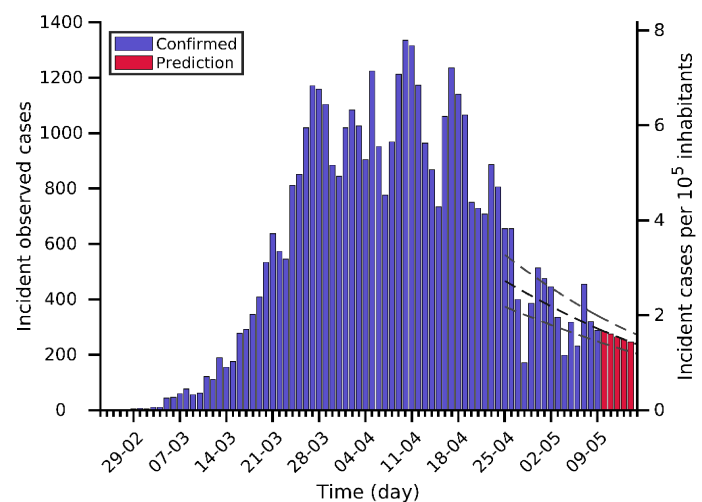
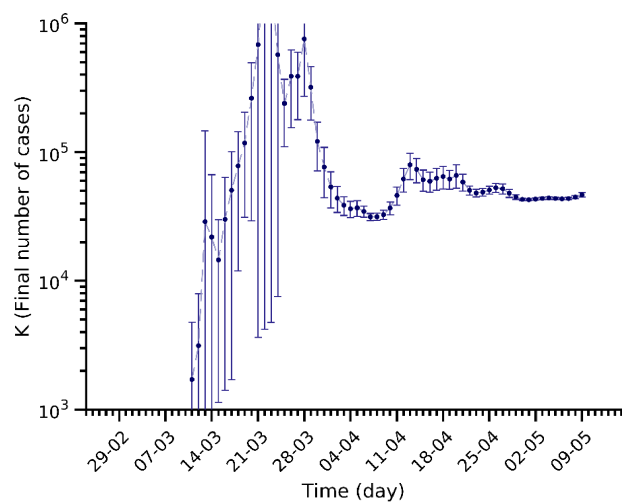
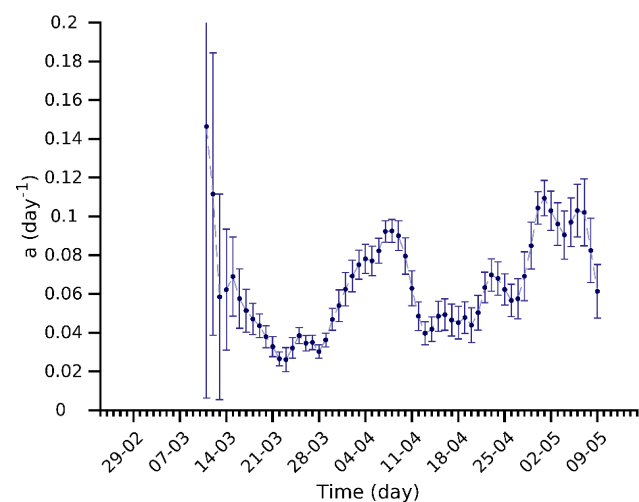
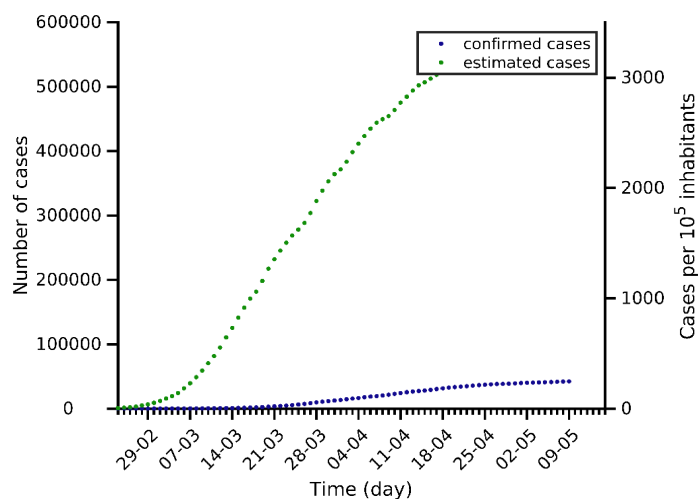
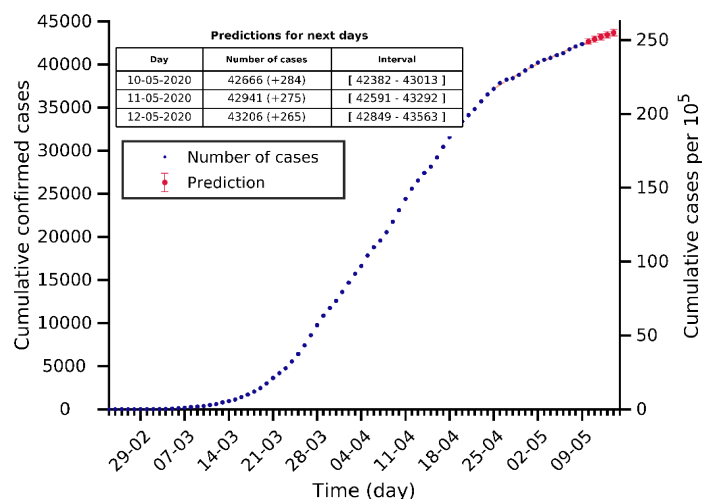
France 09-05-2020. Population: 65.3M. Current cumulated incidence: 213/10⁵



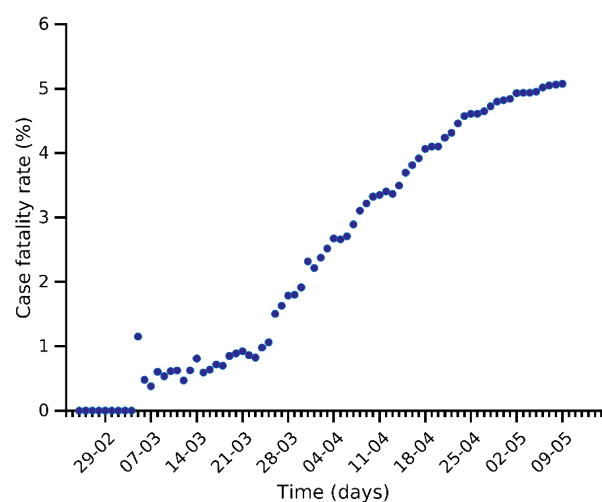
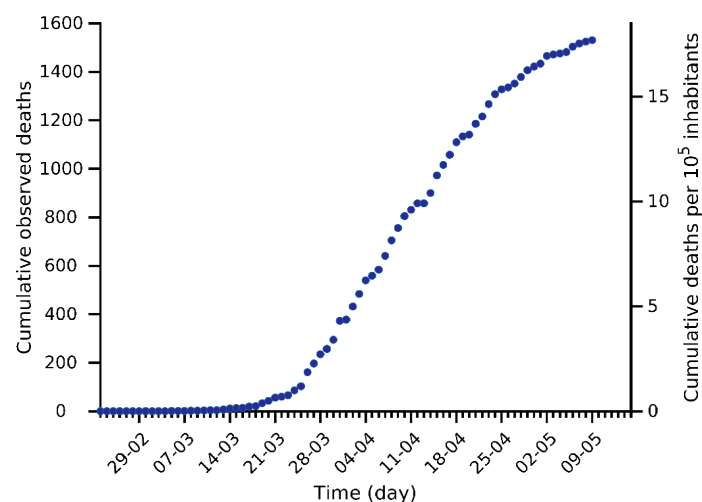
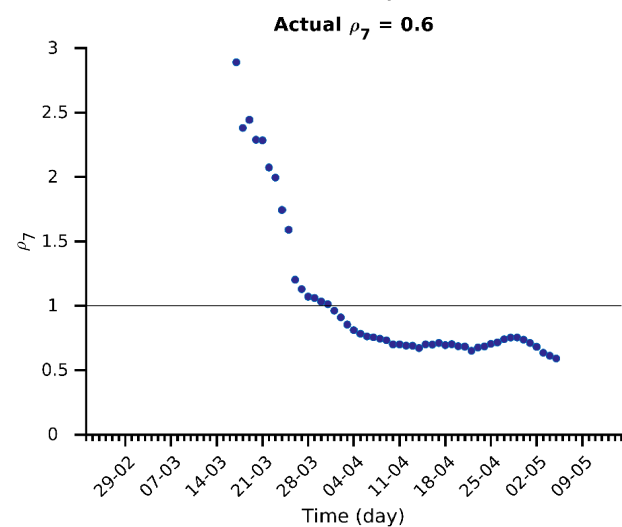
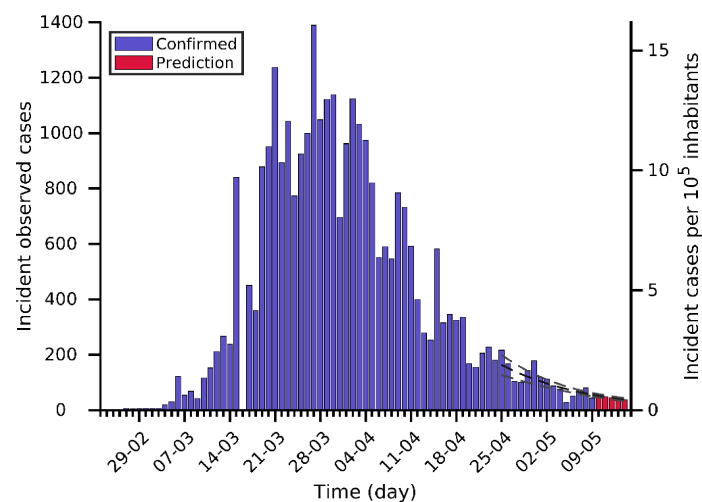
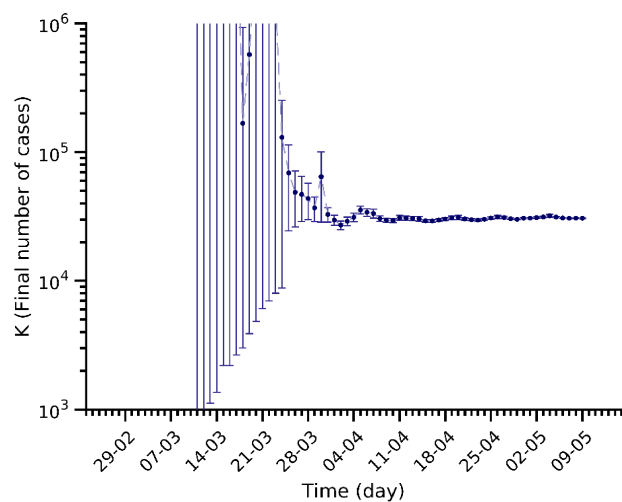
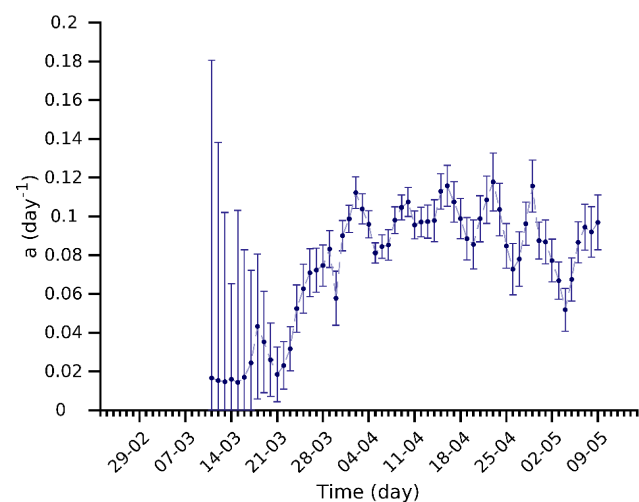
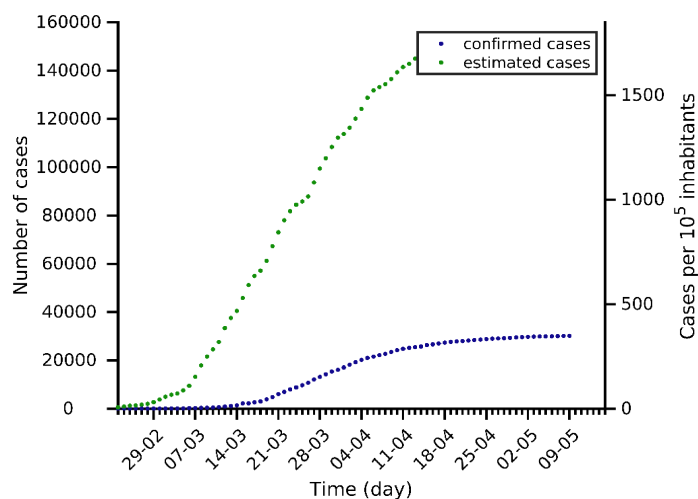
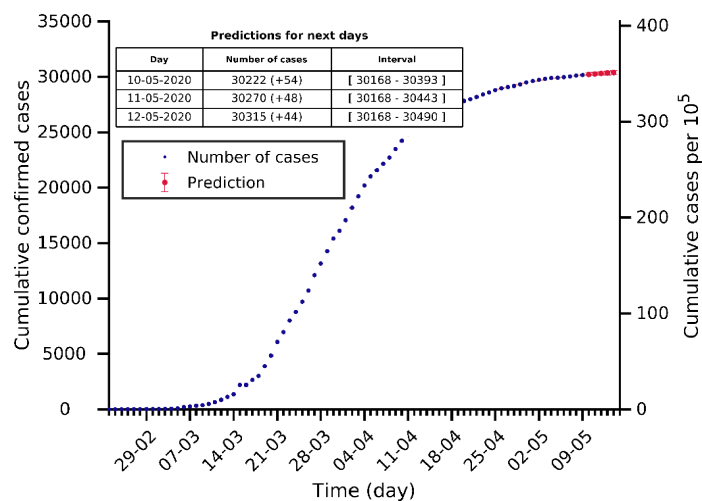
Belgium 09-05-2020. Population: 11.6M. Current cumulated incidence: 454/10⁵



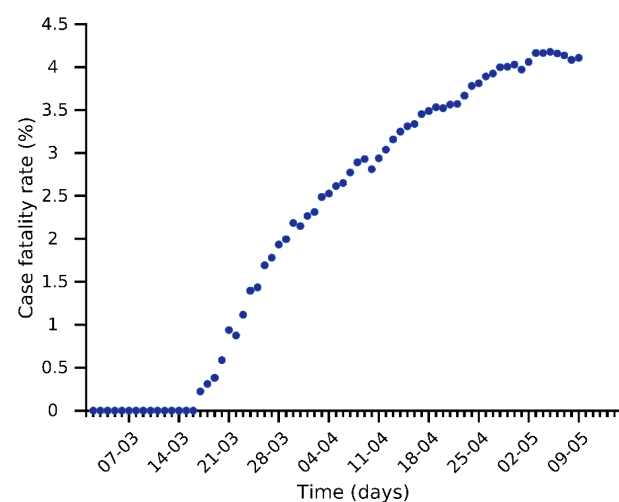
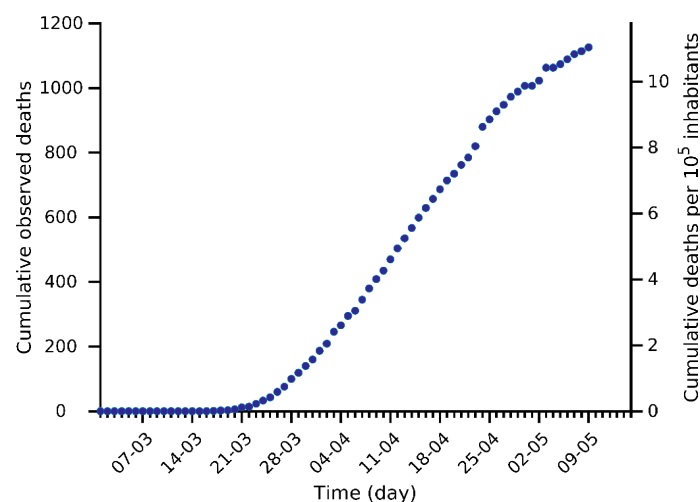
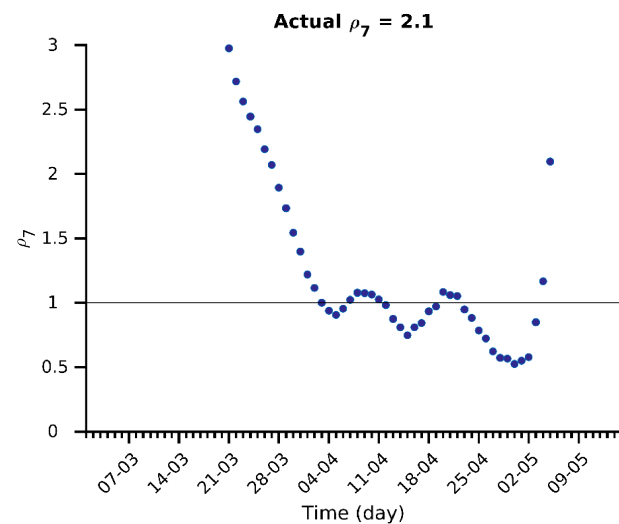
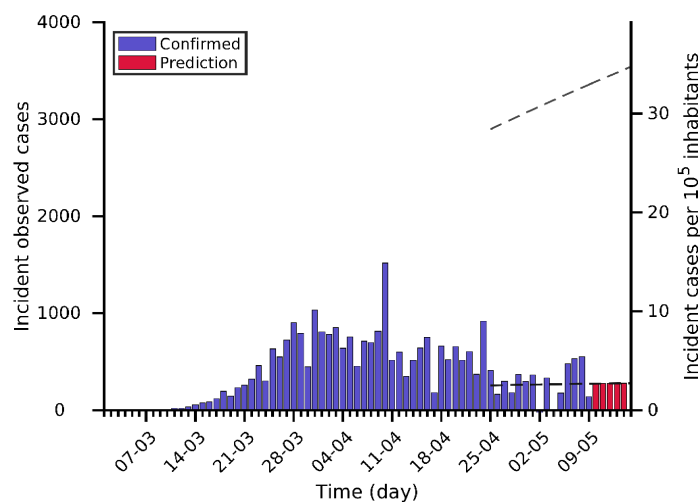
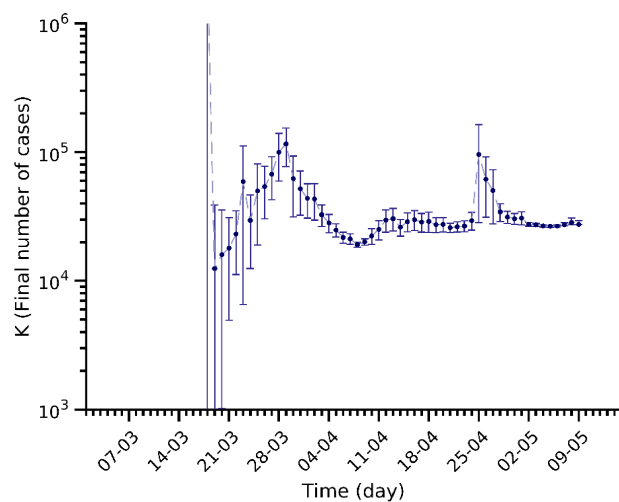
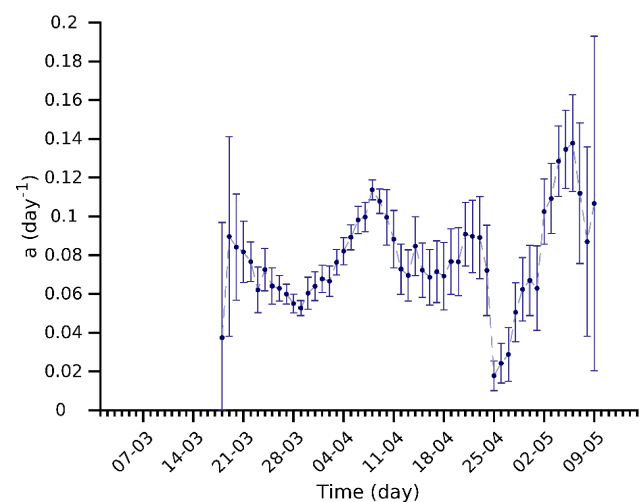
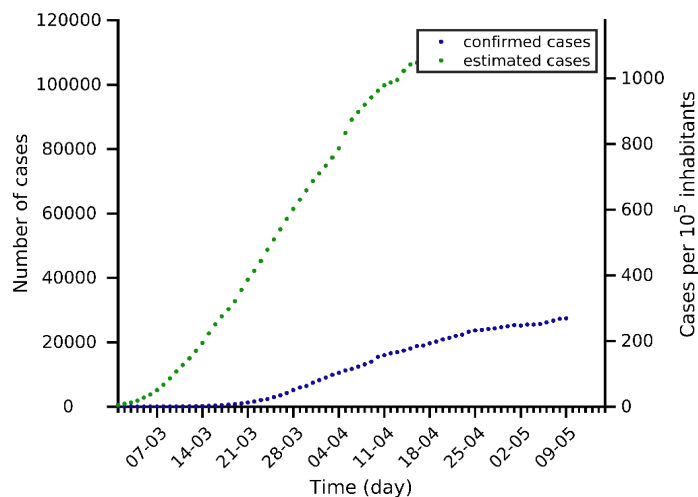
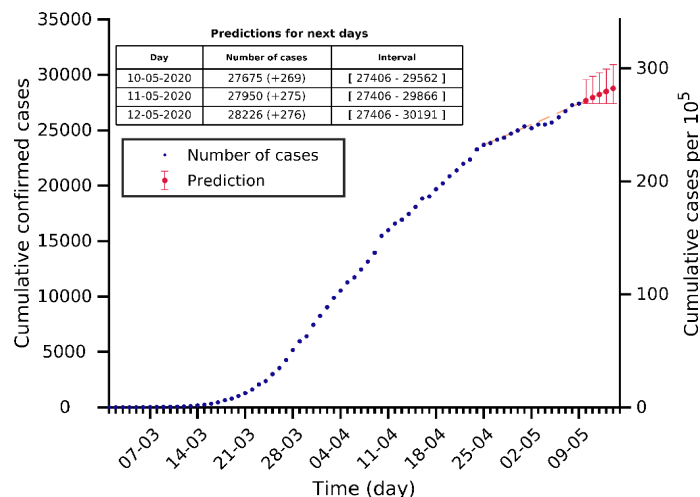
Netherlands 09-05-2020. Population: 17.1M. Current cumulated incidence: 247/10⁵



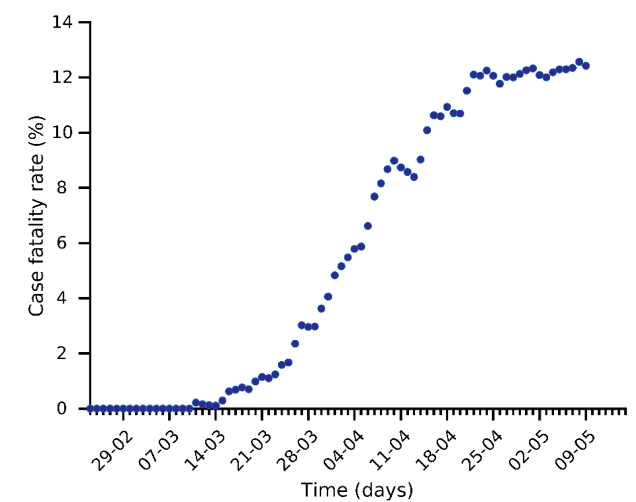
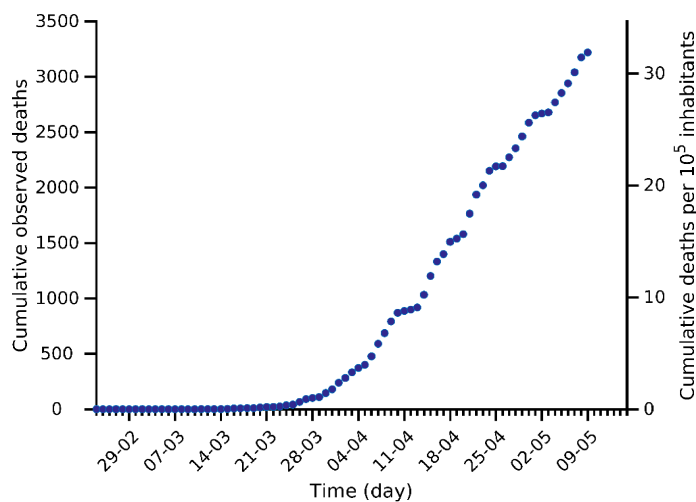
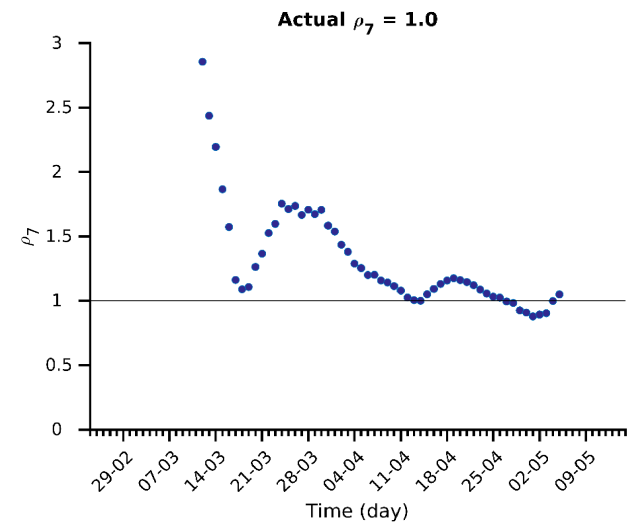
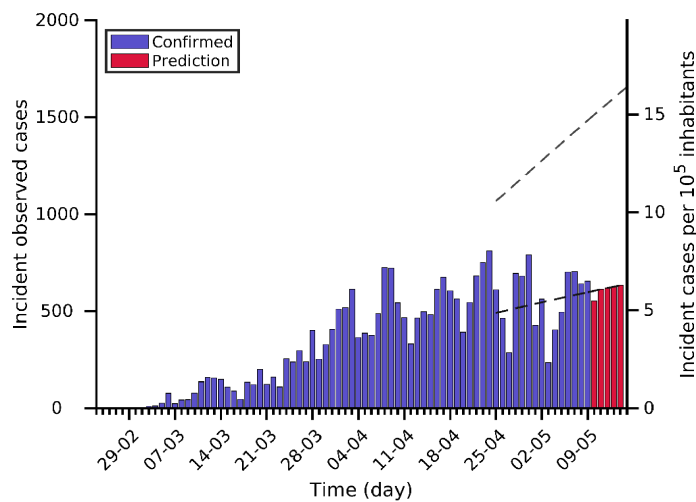
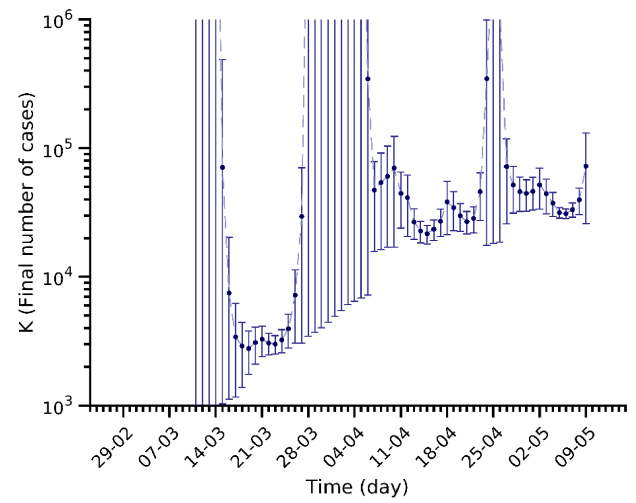
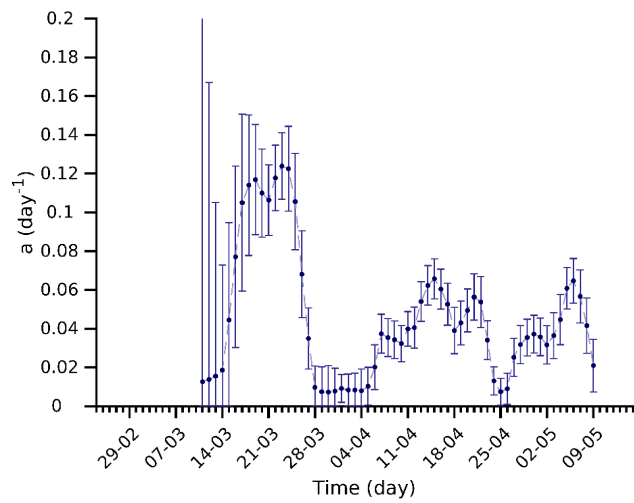
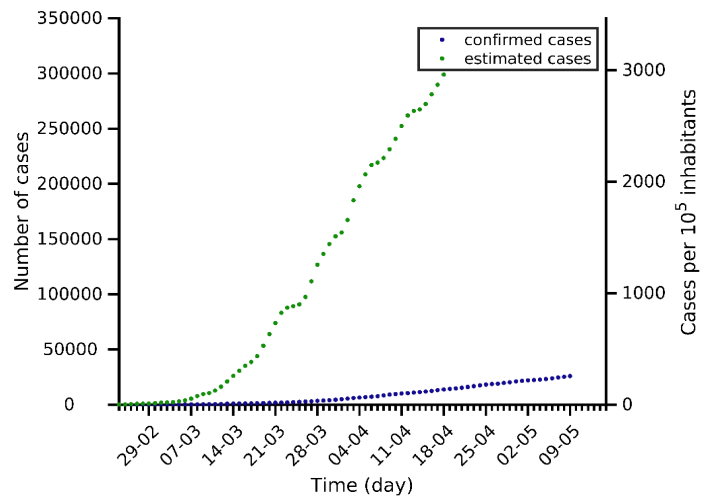
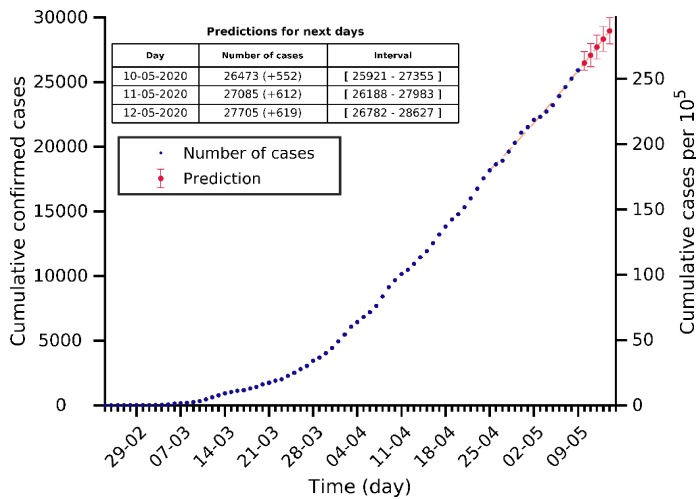
Switzerland 09-05-2020. Population: 8.7M. Current cumulated incidence: 349/10⁵



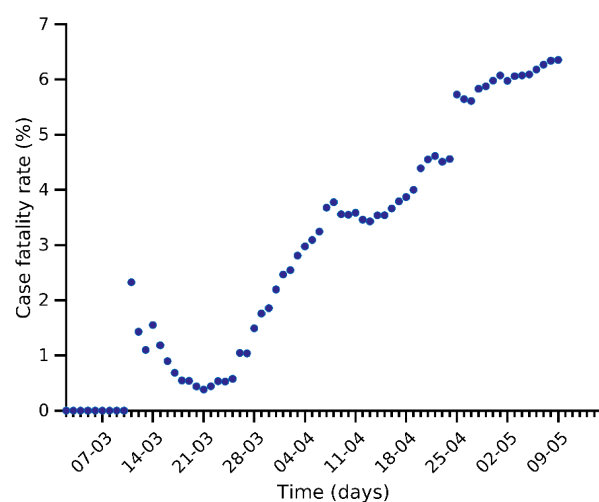
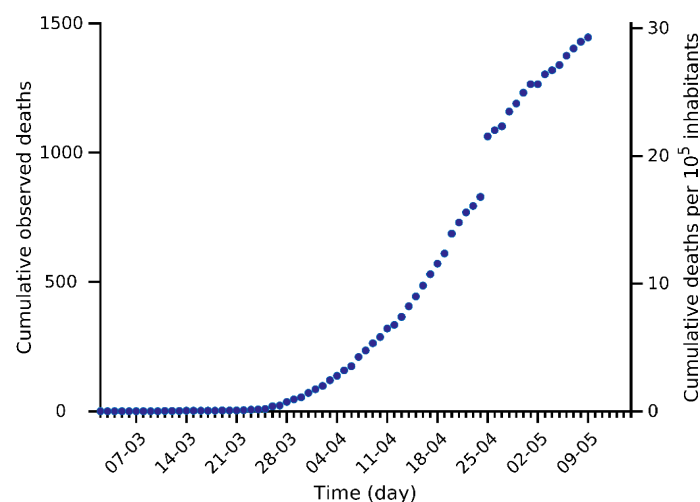
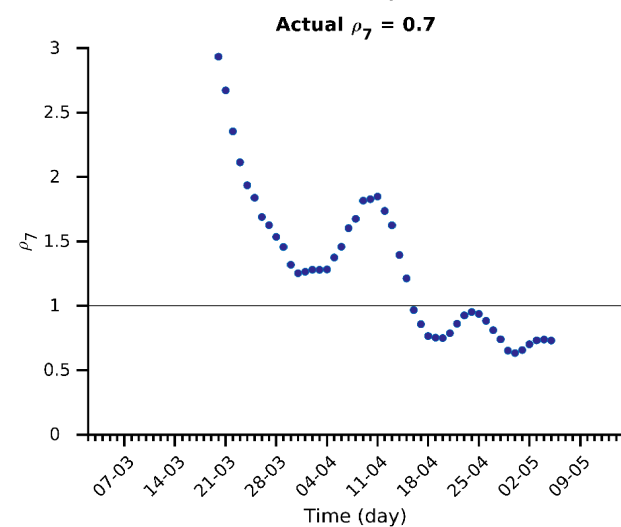
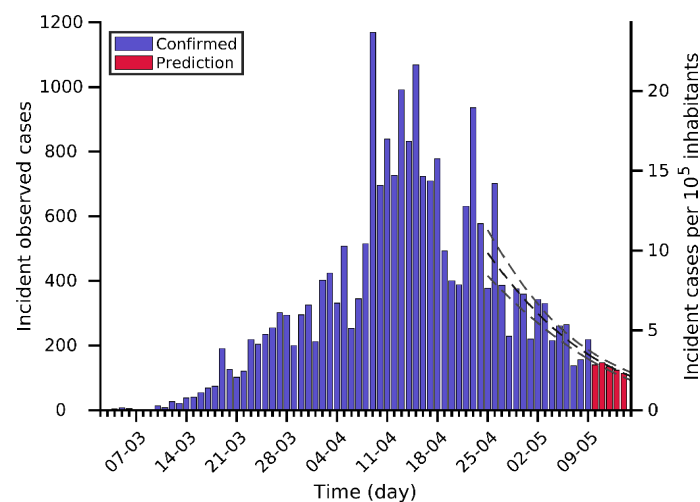
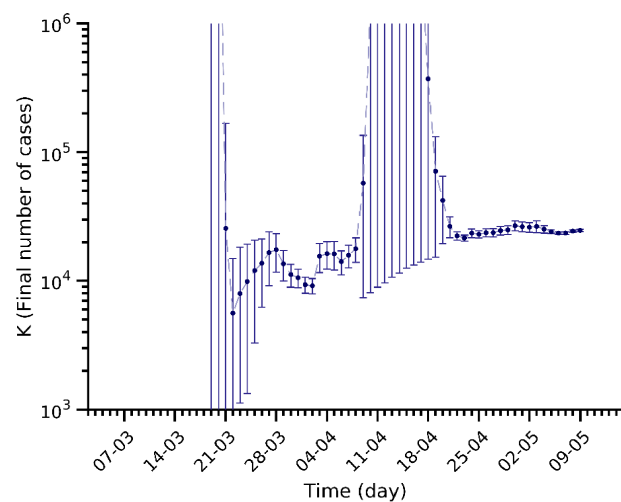
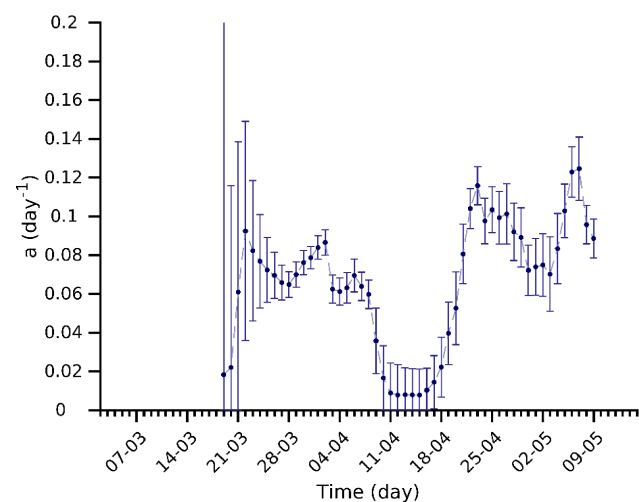
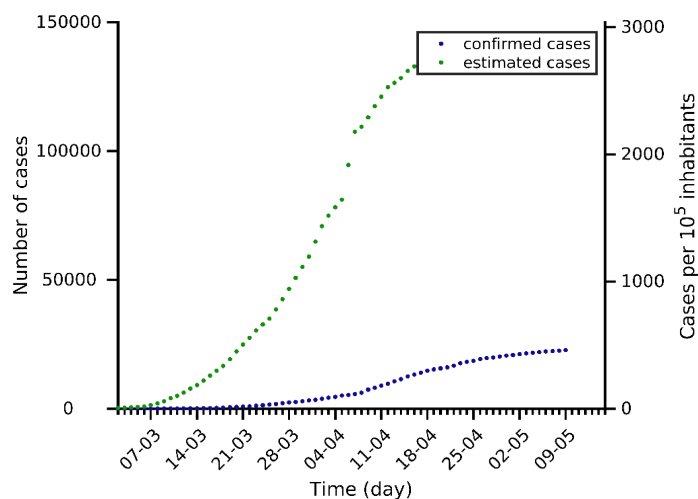
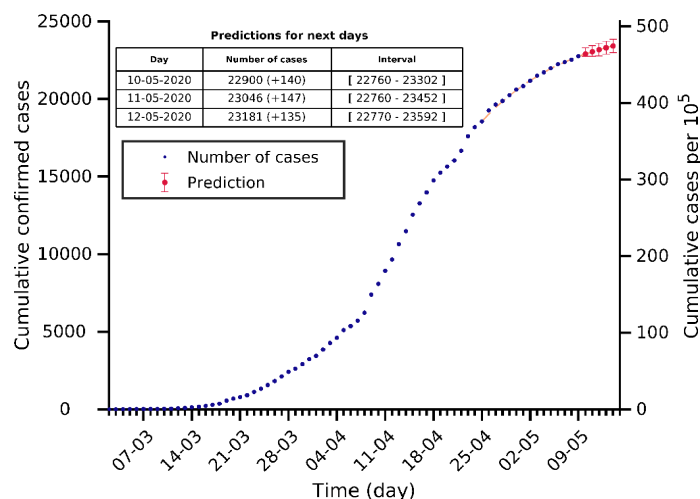
Portugal 09-05-2020. Population: 10.2M. Current cumulated incidence: 269/10⁵



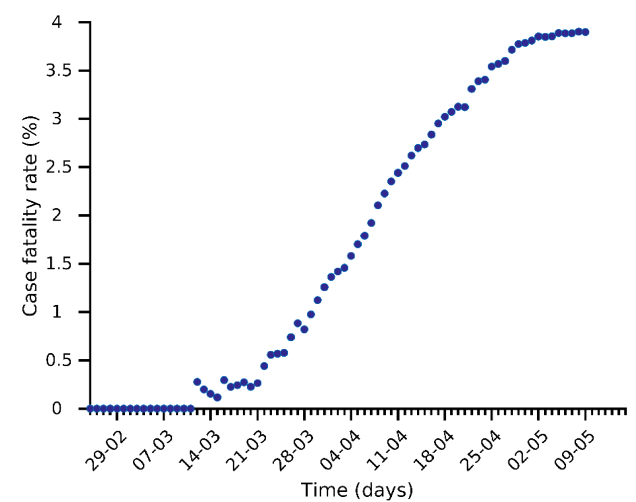
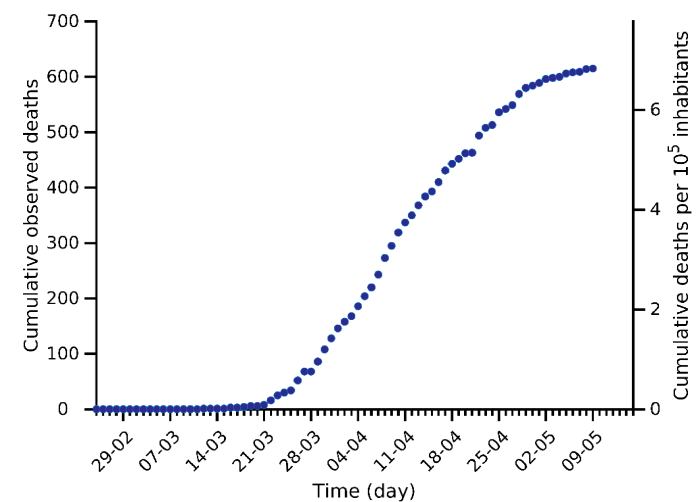
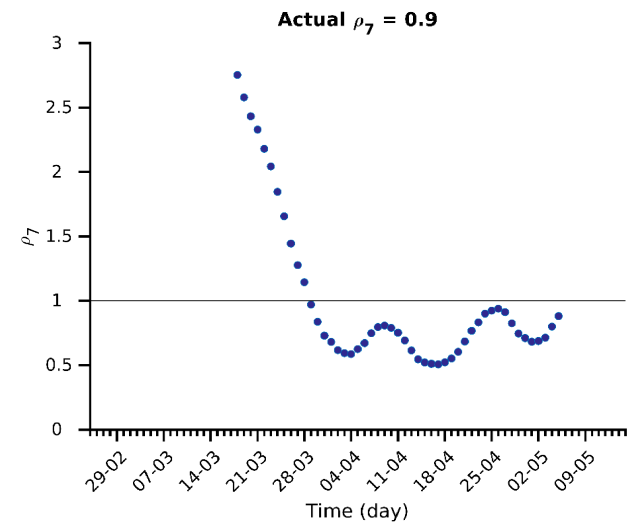
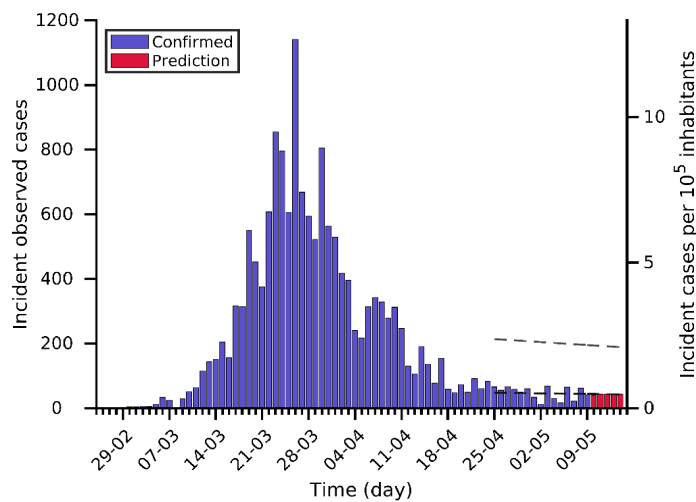
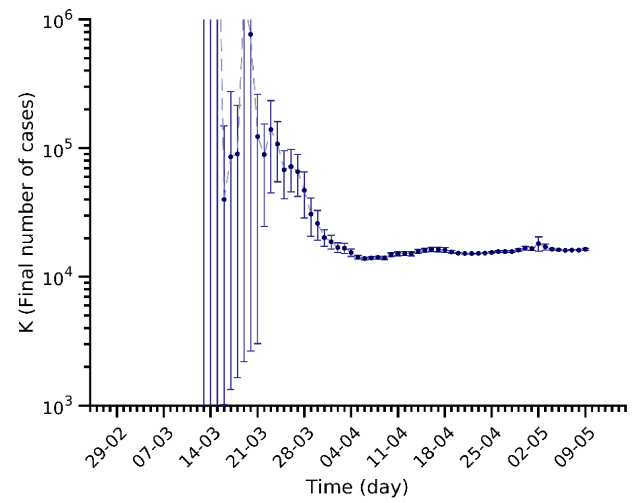
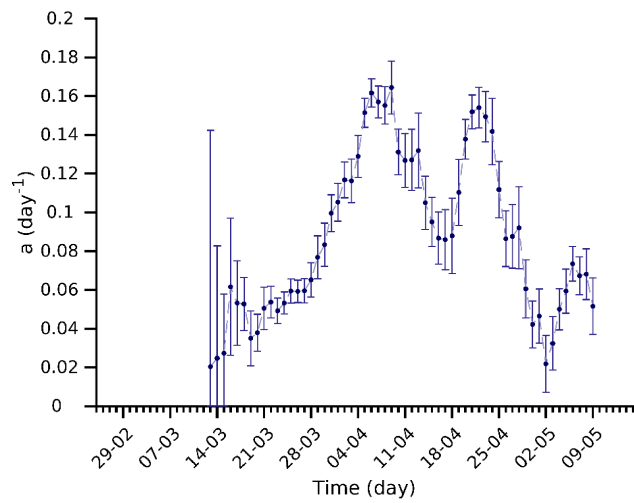
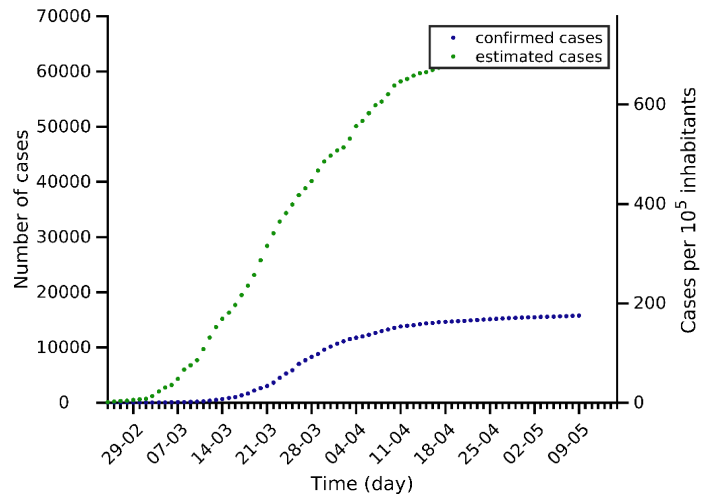
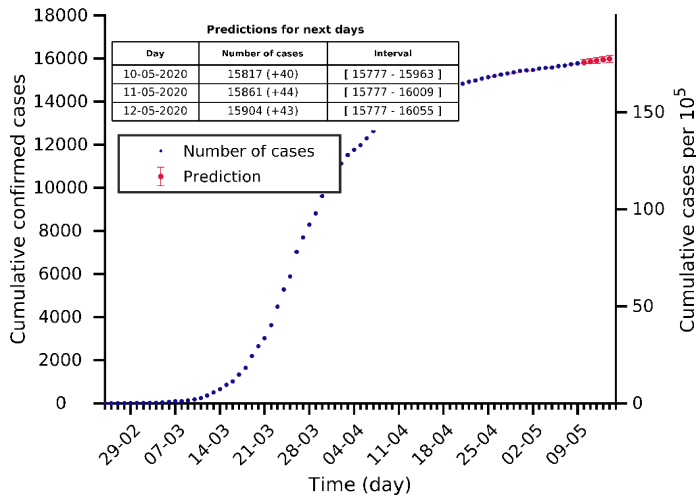
Sweden 09-05-2020. Population: 10.1M. Current cumulated incidence: 257/10⁵



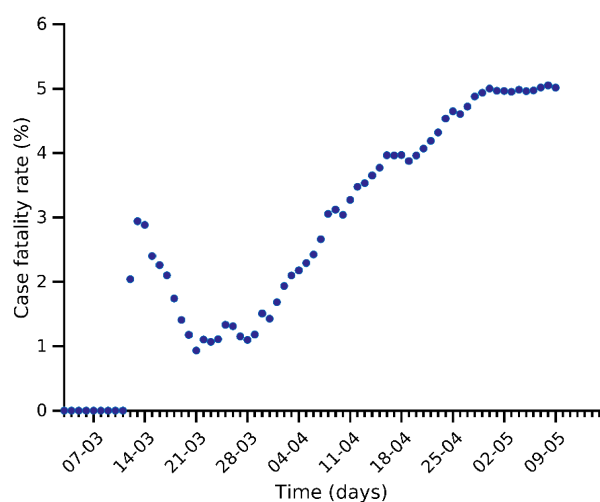
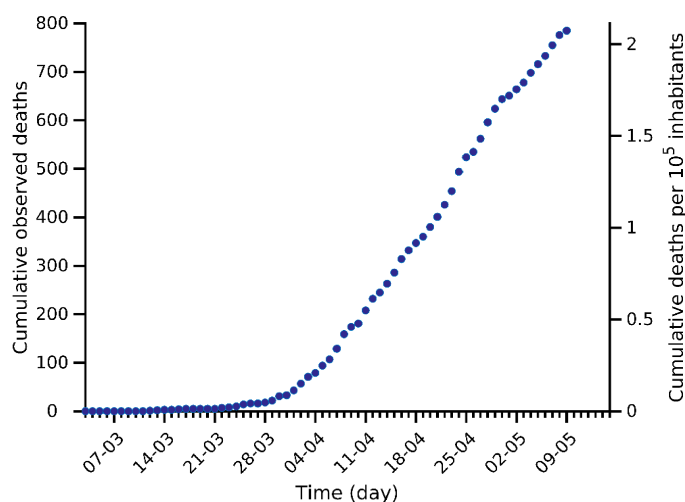
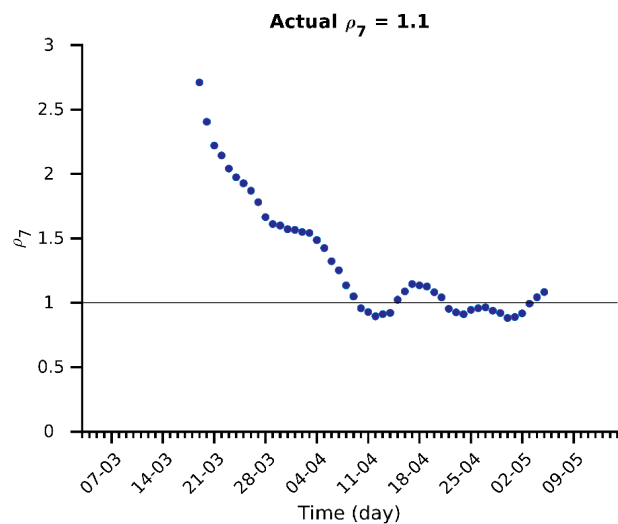
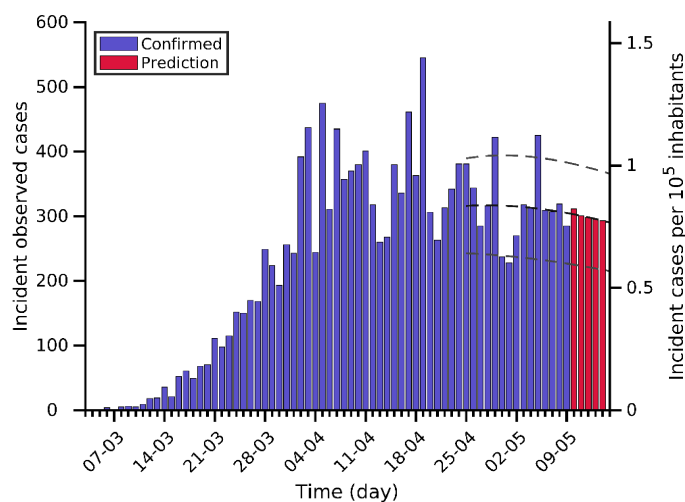
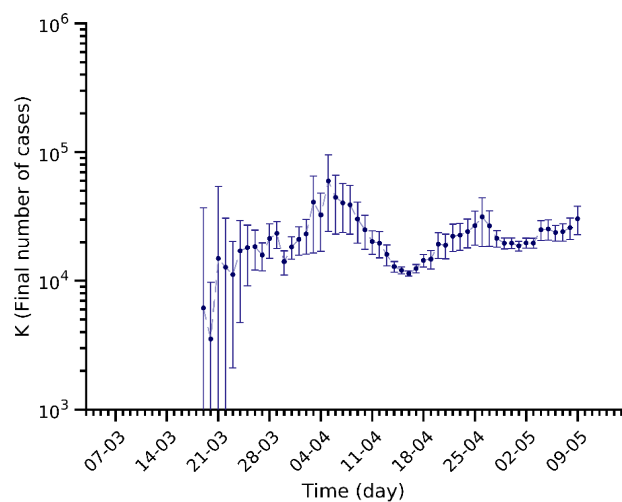
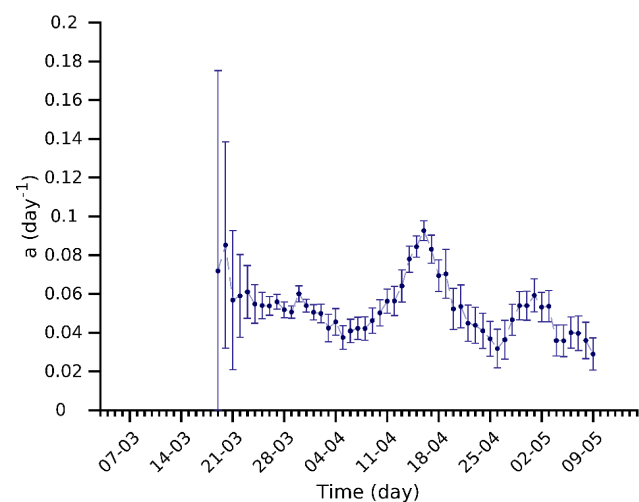
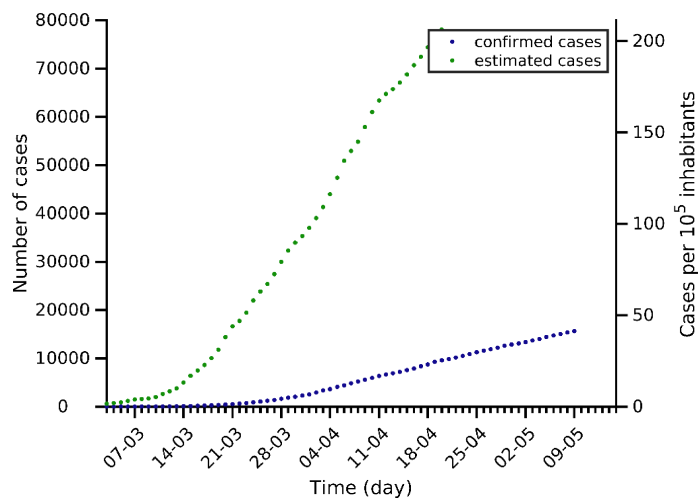
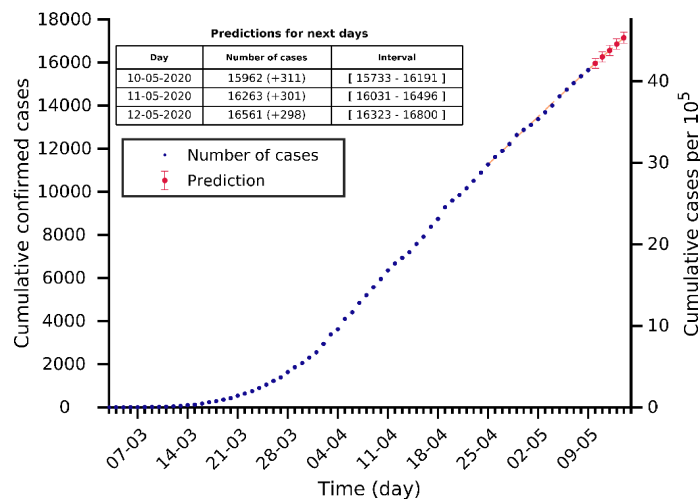
Ireland 09-05-2020. Population: 4.9M. Current cumulated incidence: 461/10⁵



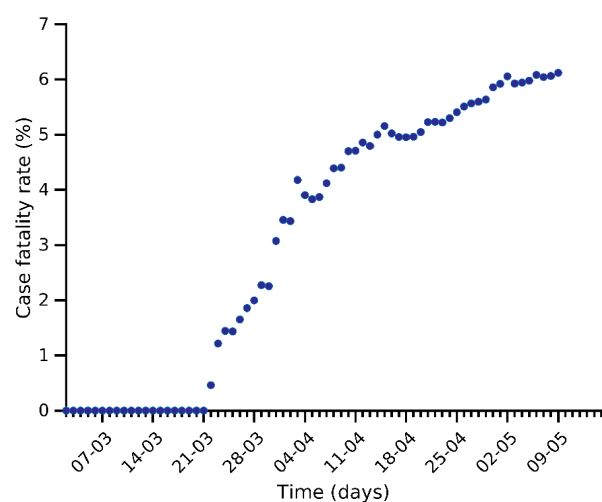
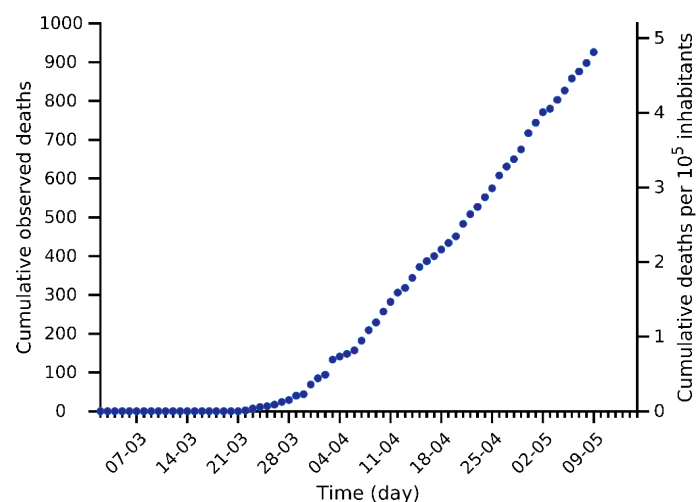
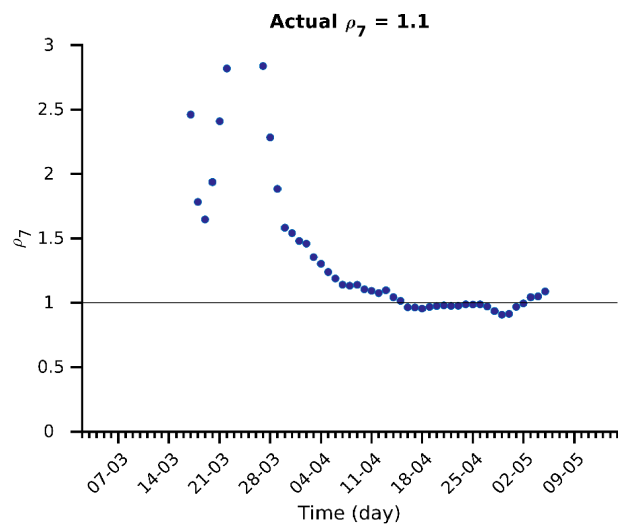
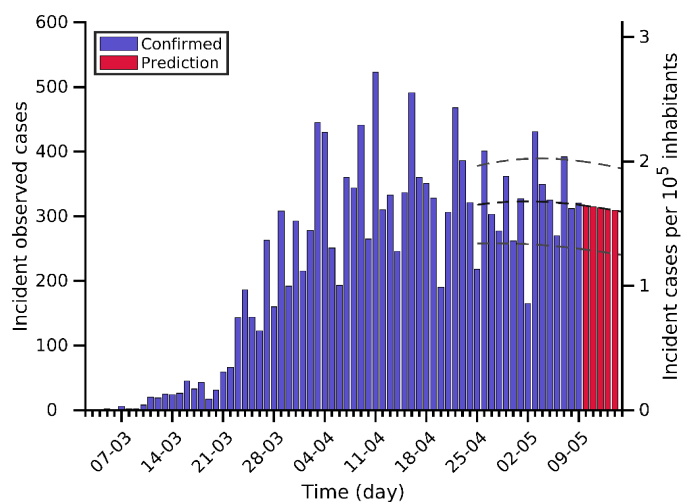
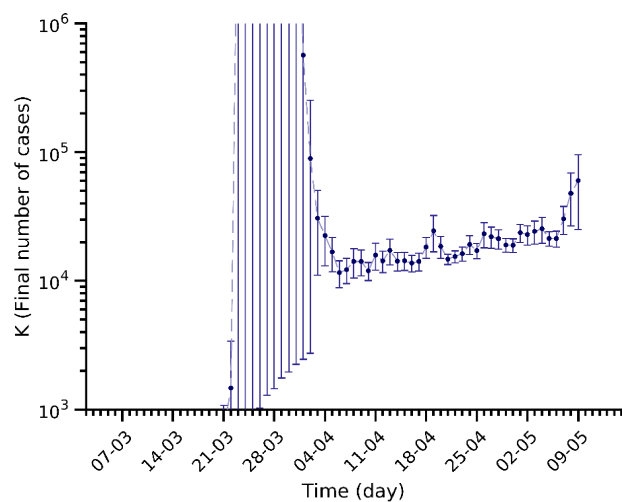
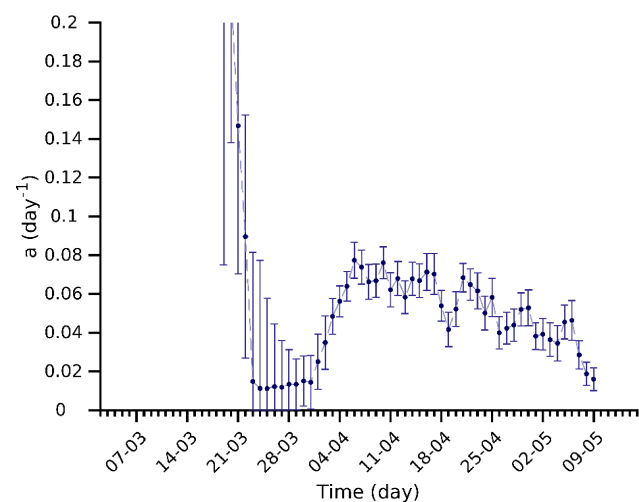
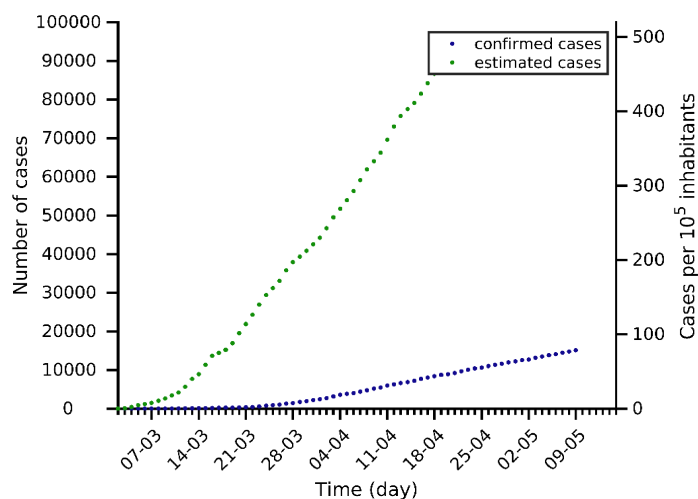
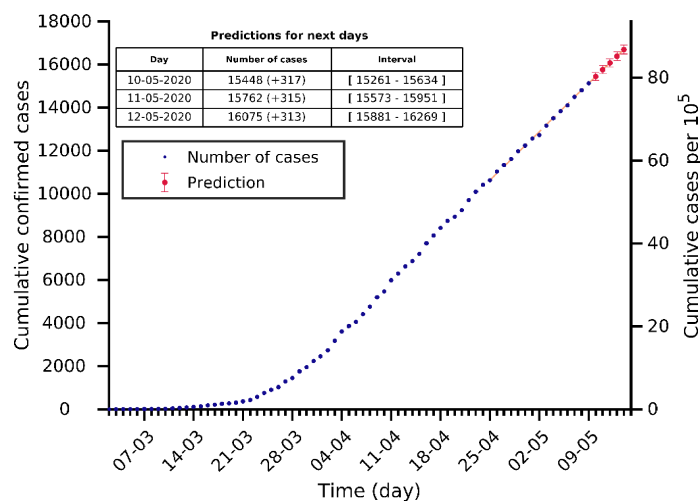
Austria 09-05-2020. Population: 9.0M. Current cumulated incidence: 175/10⁵



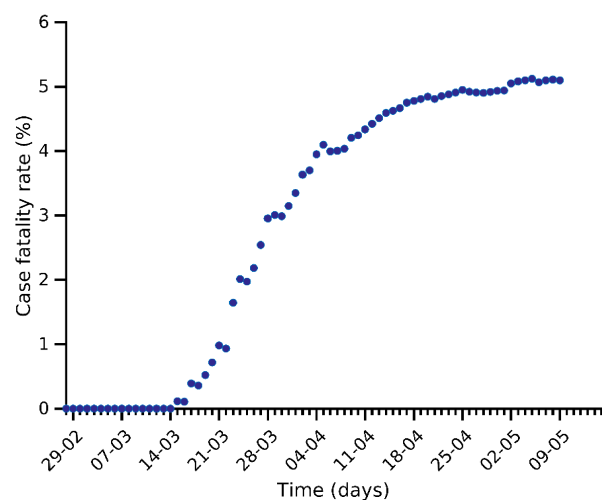
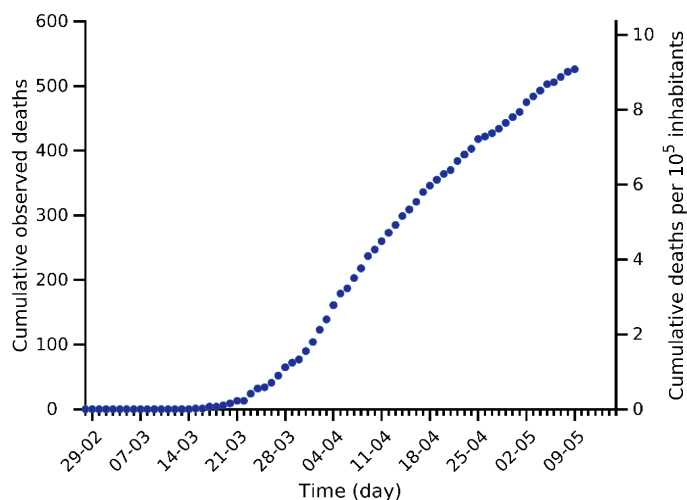
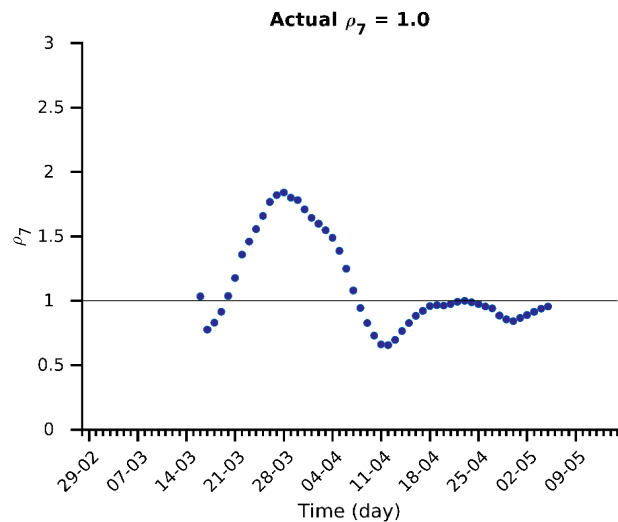
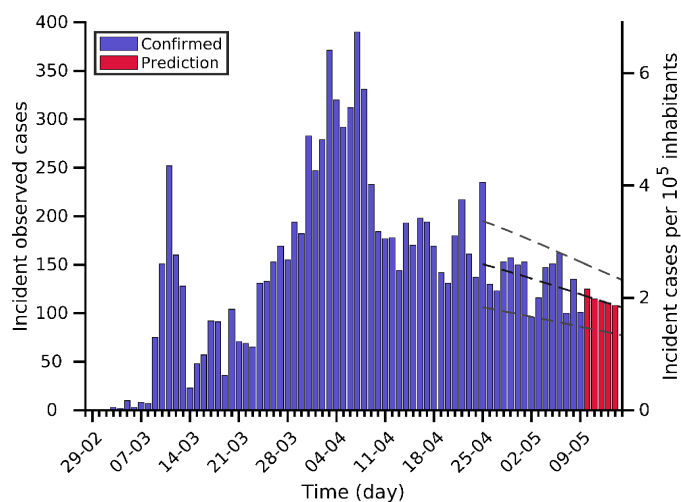
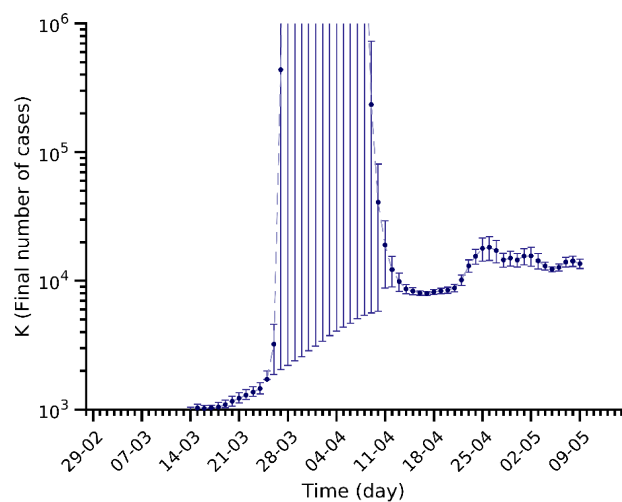
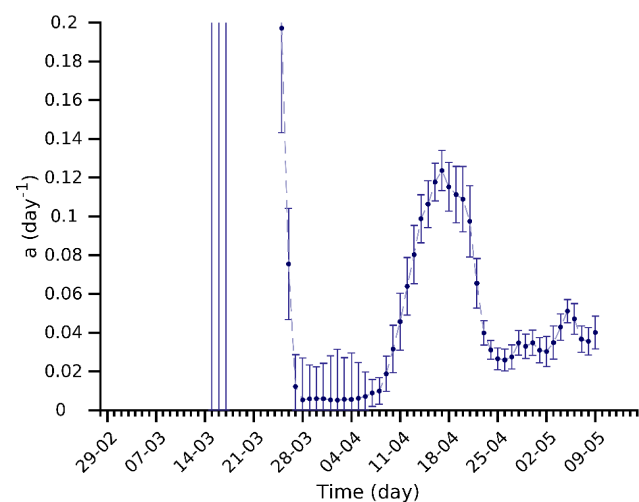
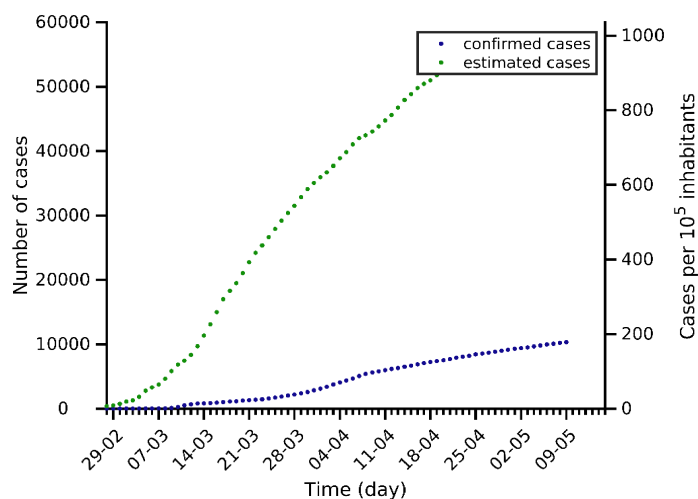
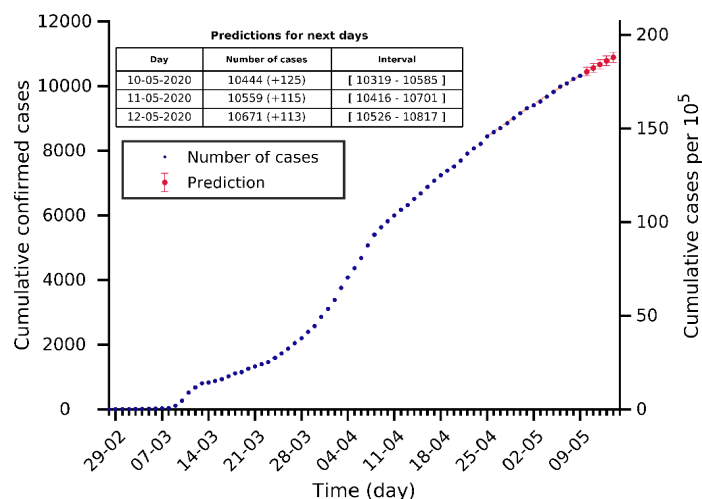
Poland 09-05-2020. Population: 37.8M. Current cumulated incidence: 41/10⁵

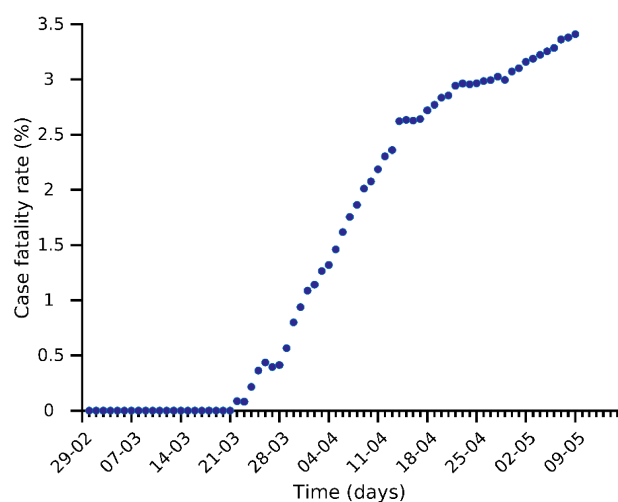
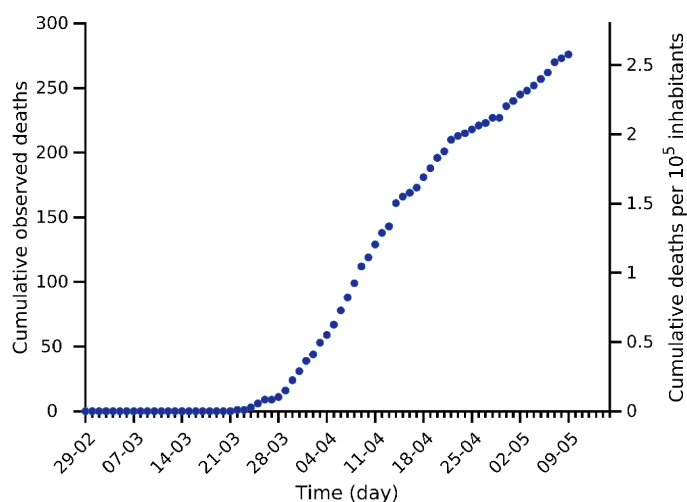
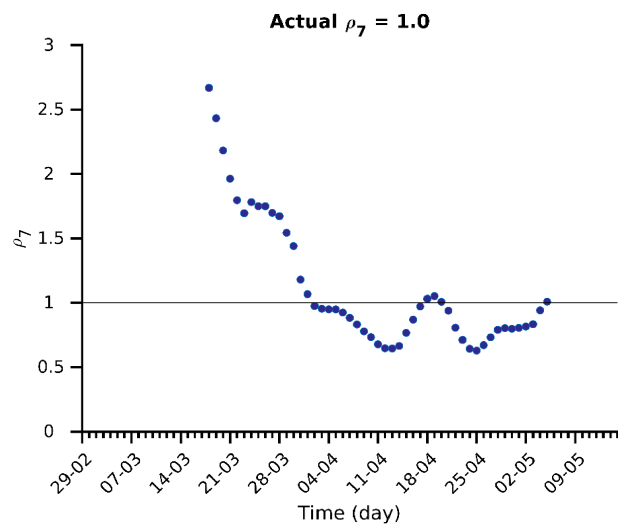
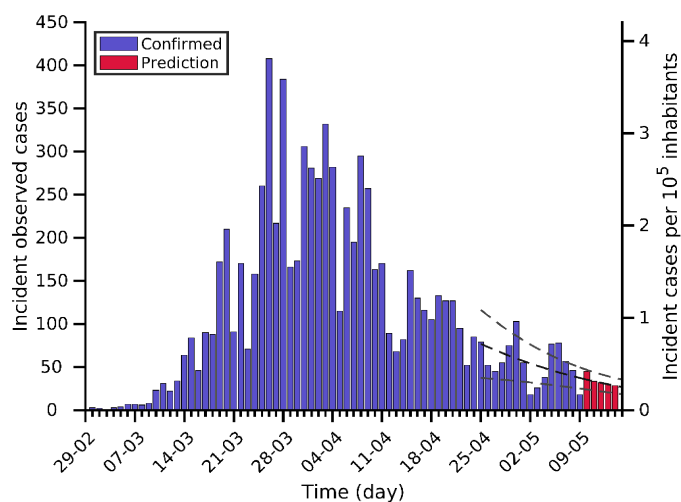
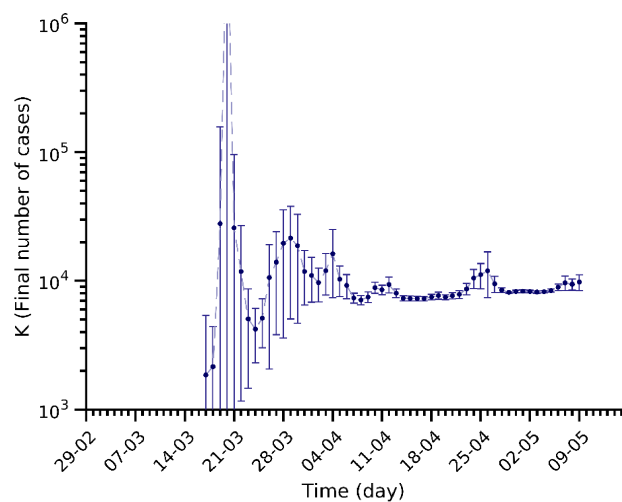
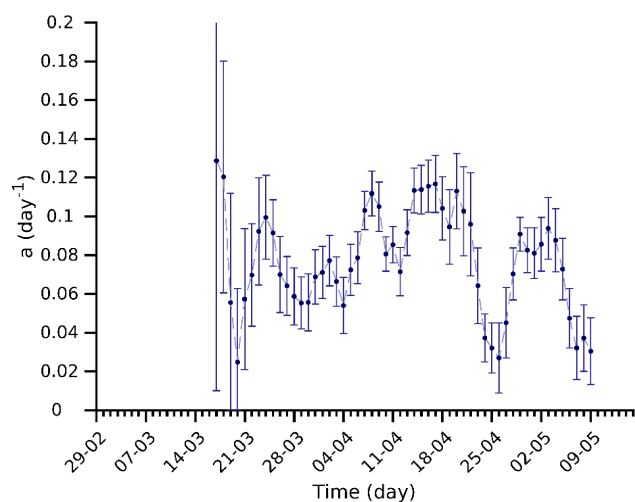
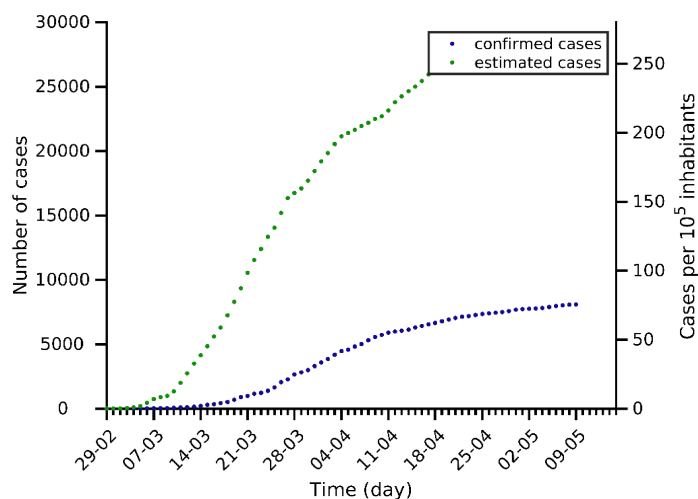
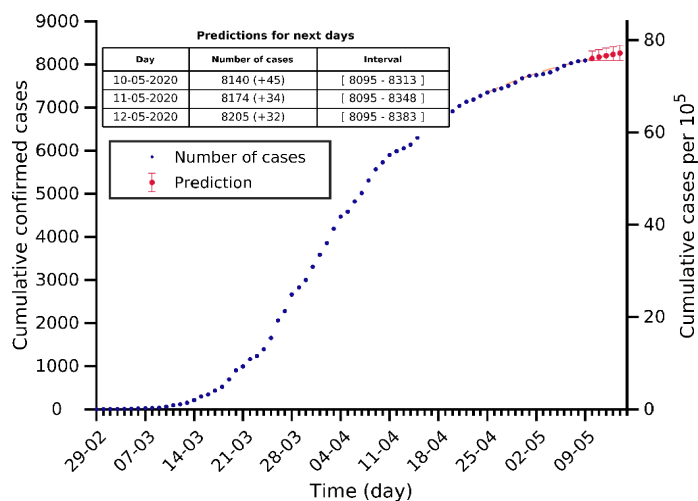


Romania 09-05-2020. Population: 19.2M. Current cumulated incidence: 79/10⁵

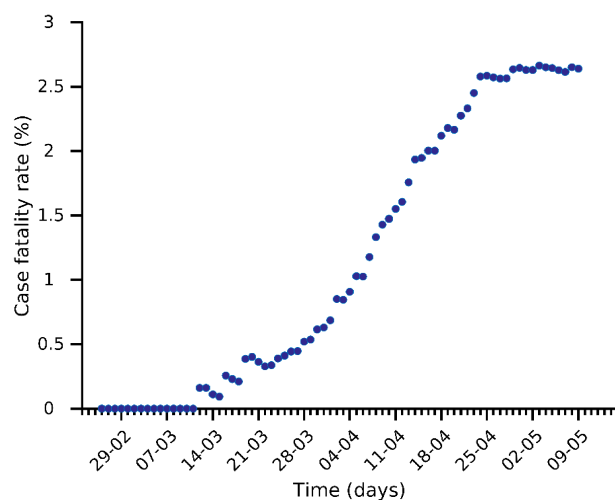
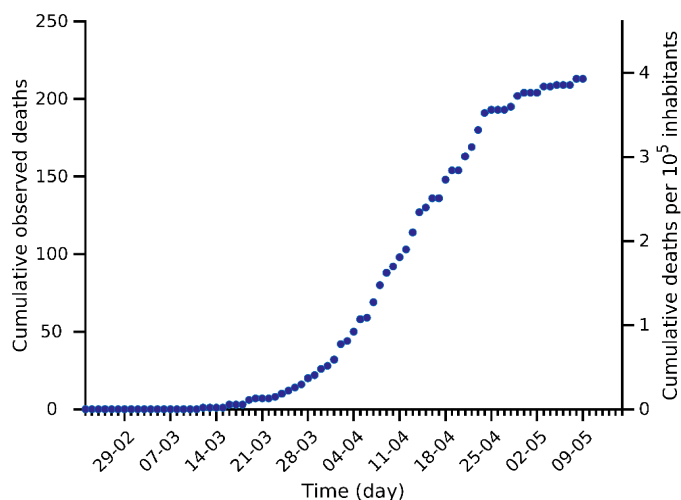
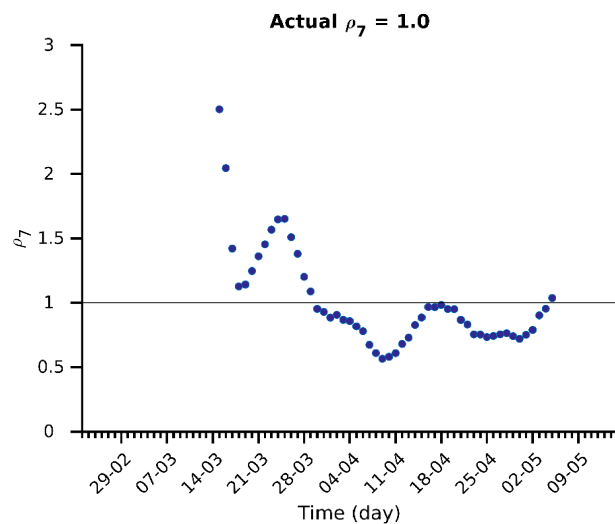
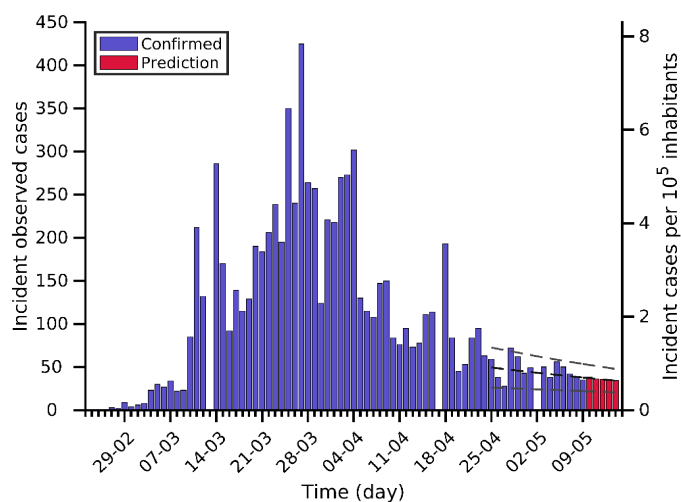
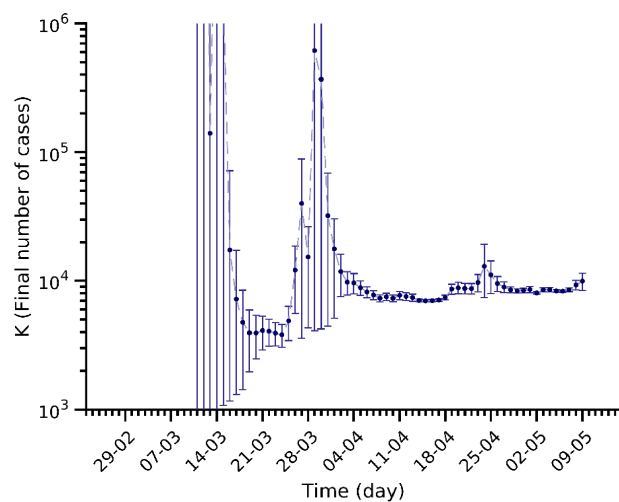
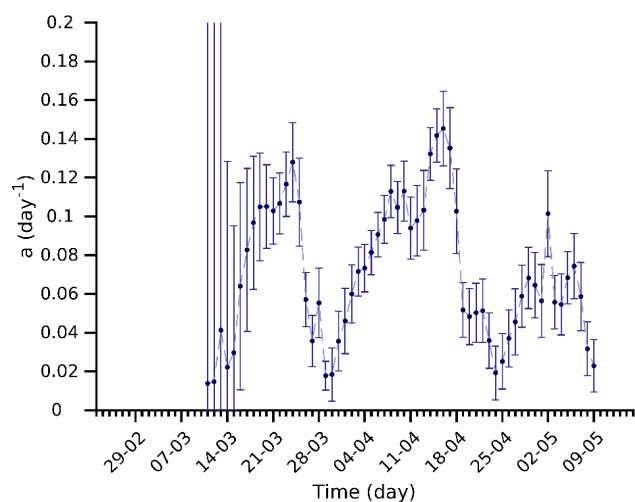
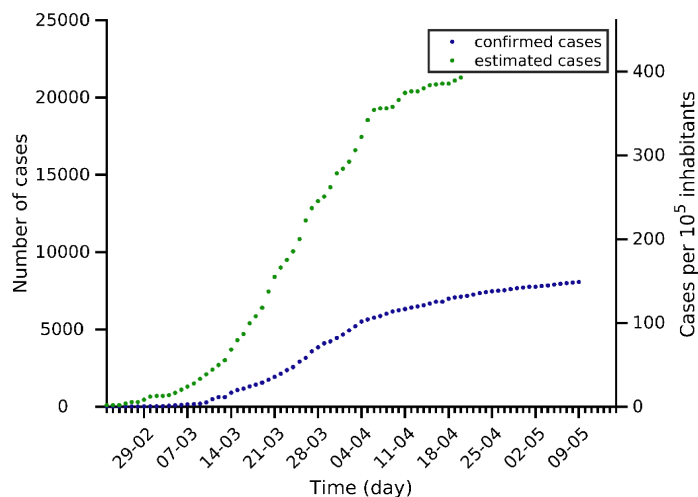
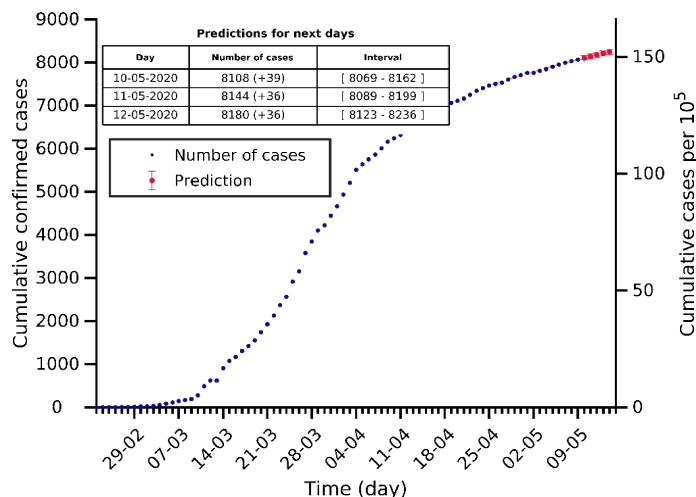


Denmark 09-05-2020. Population: 5.8M. Current cumulated incidence: 178/10⁵

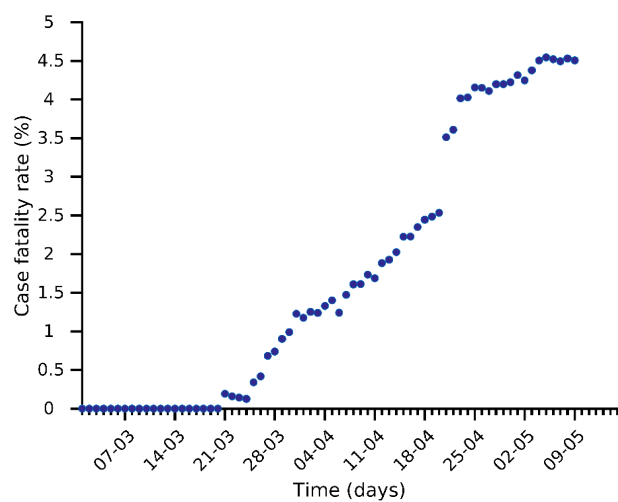
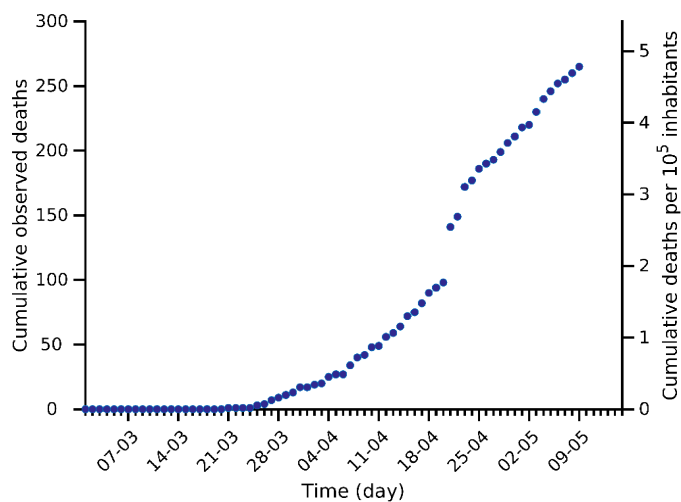
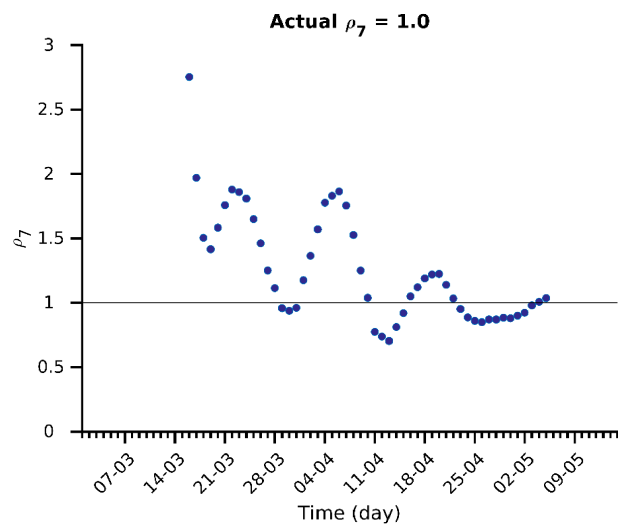
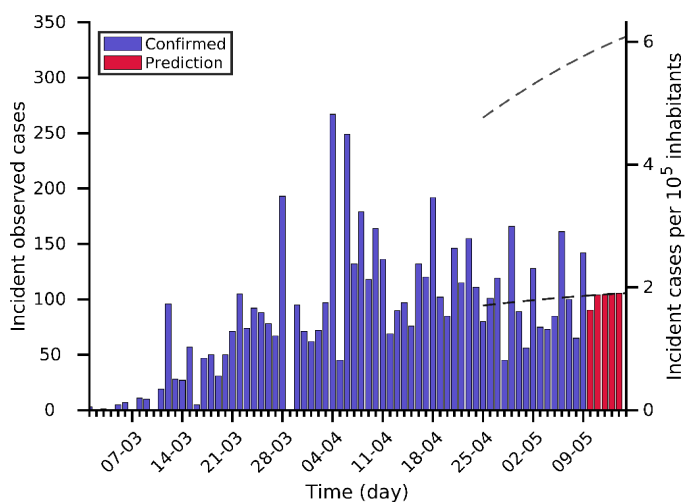
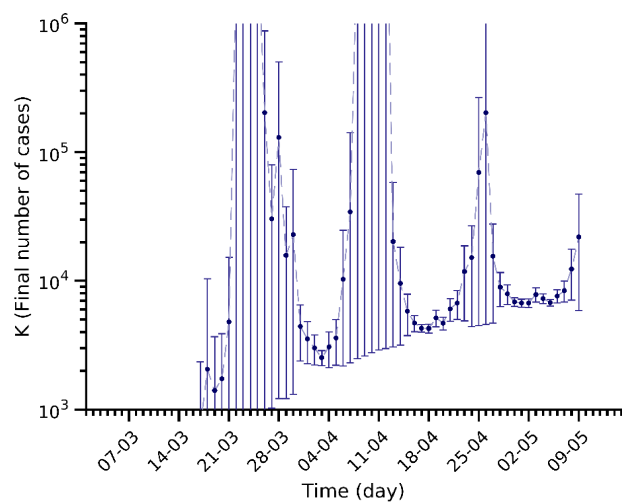
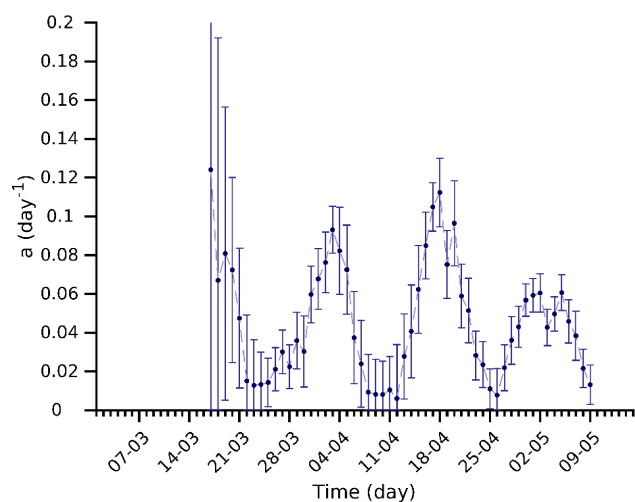
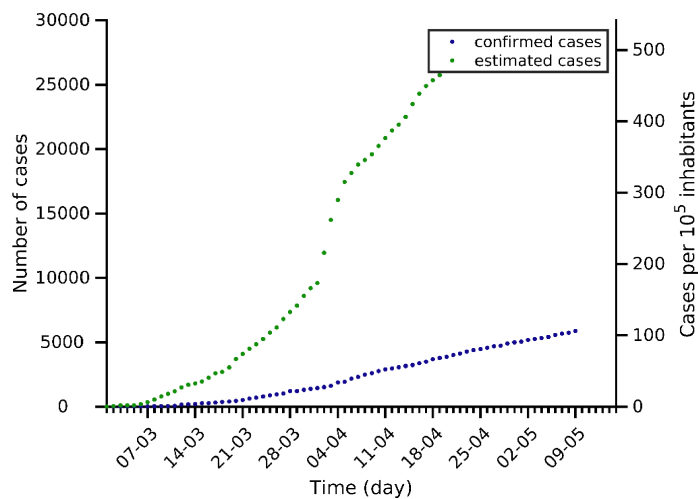
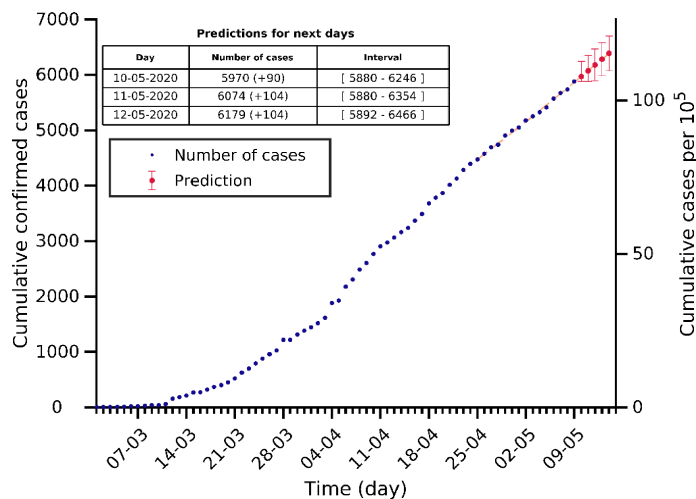




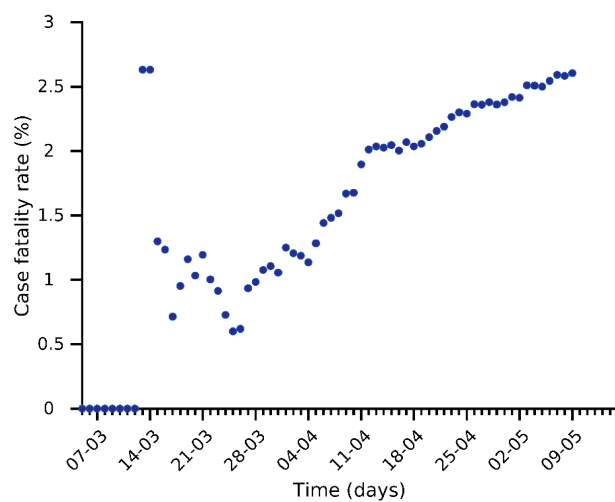
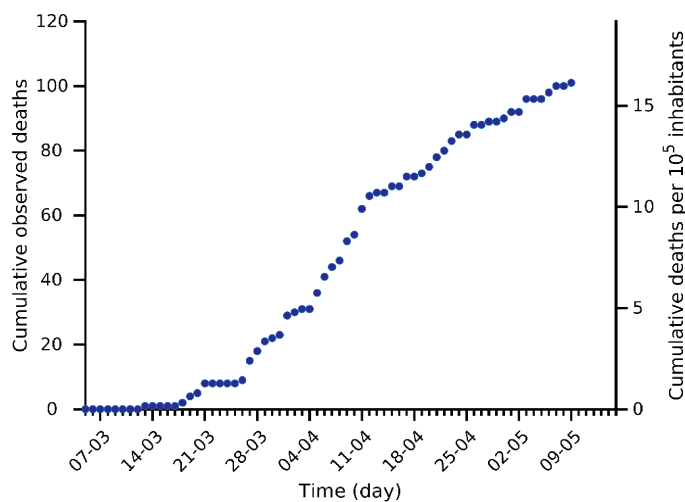
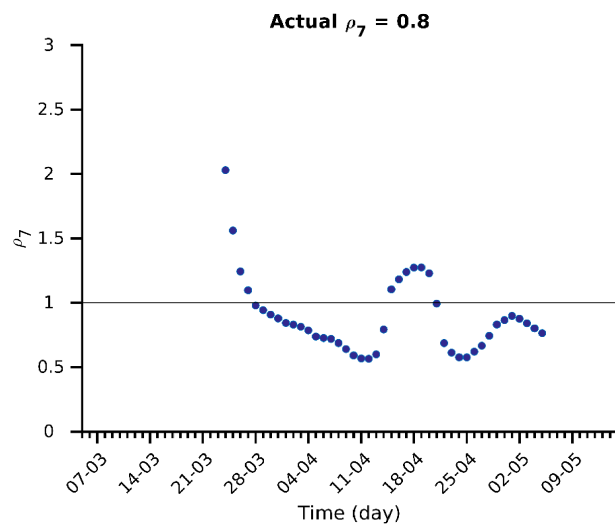
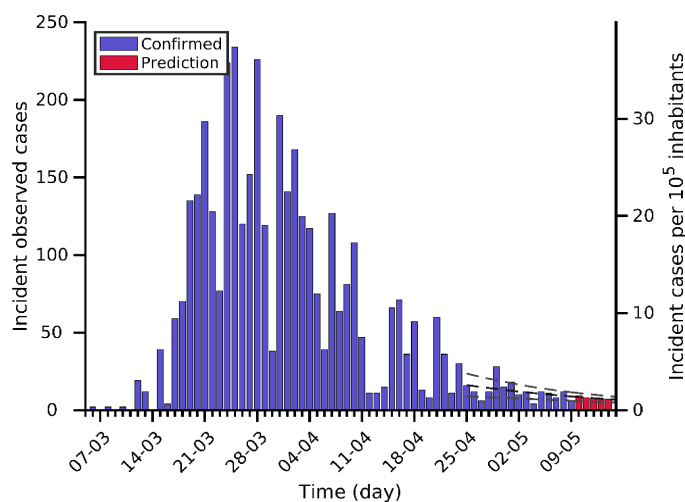
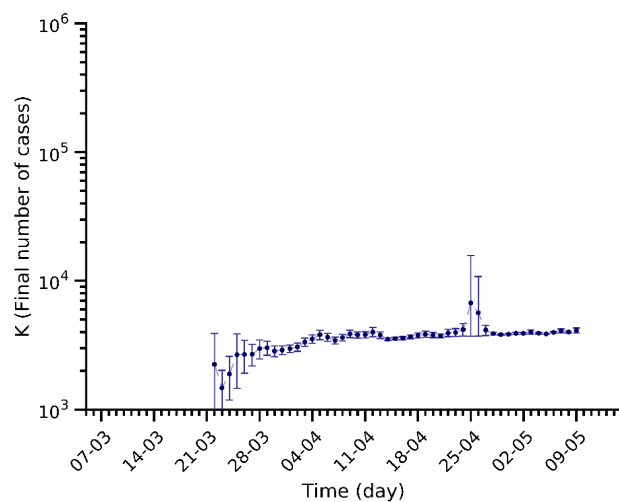
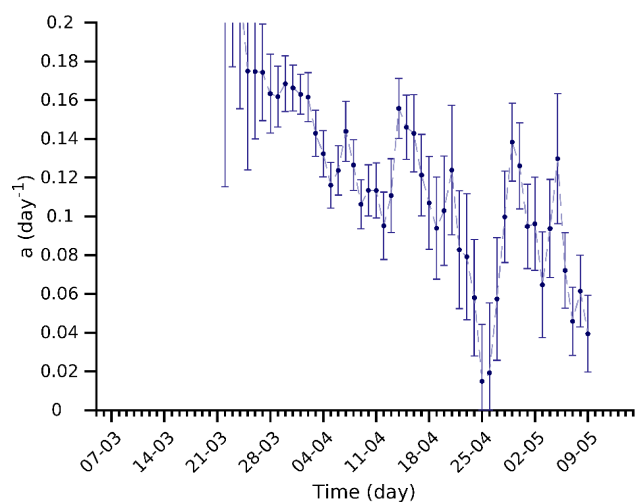
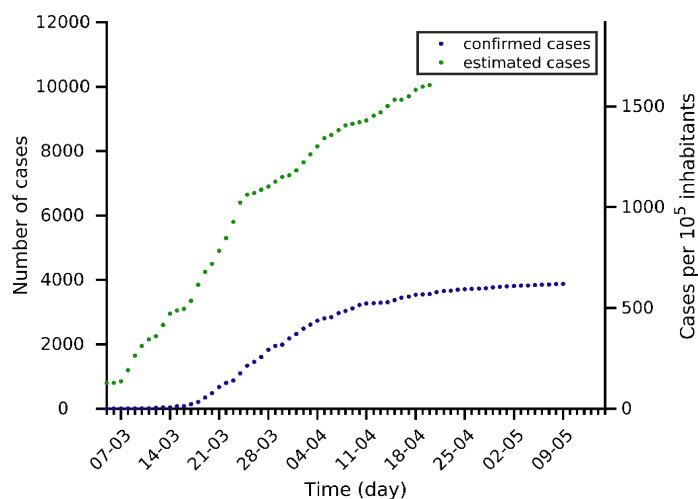
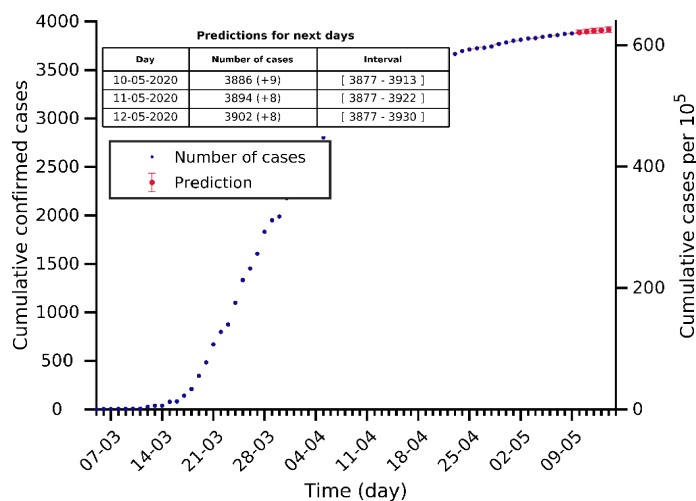
Norway 09-05-2020. Population: 5.4M. Current cumulated incidence: 149/10⁵



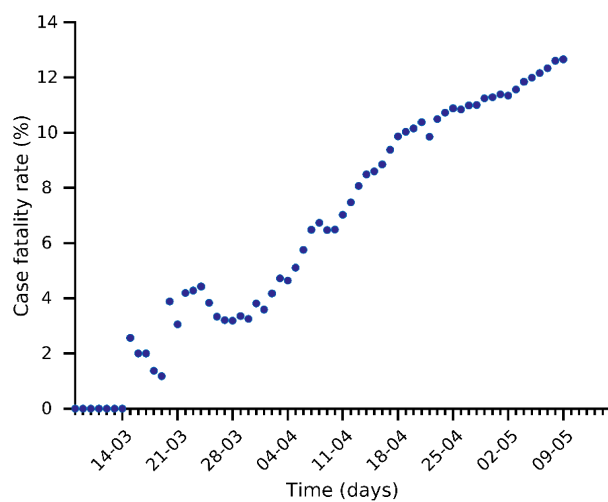
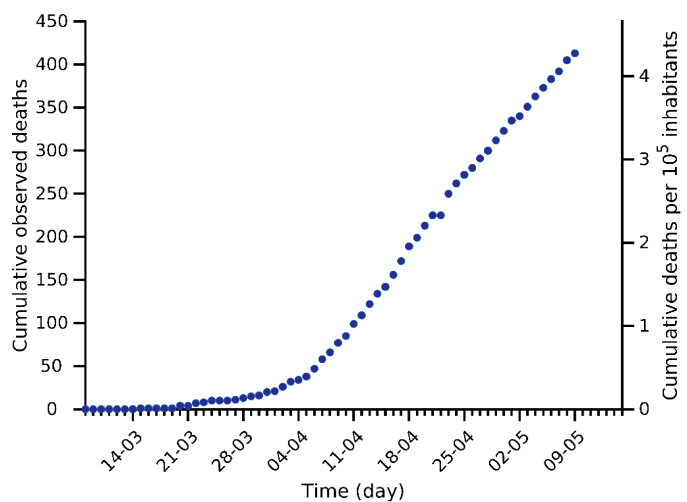
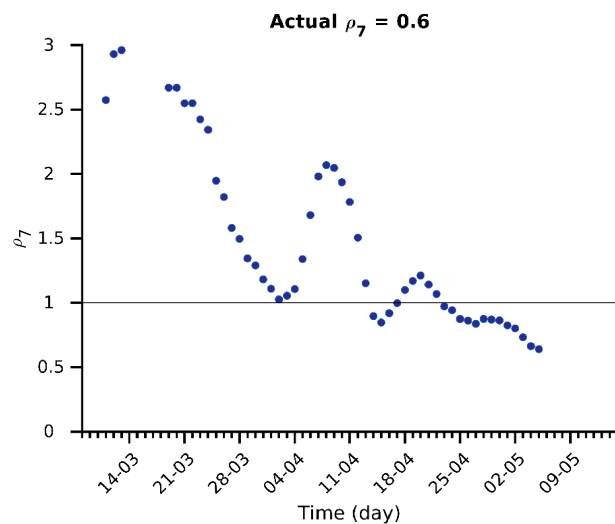
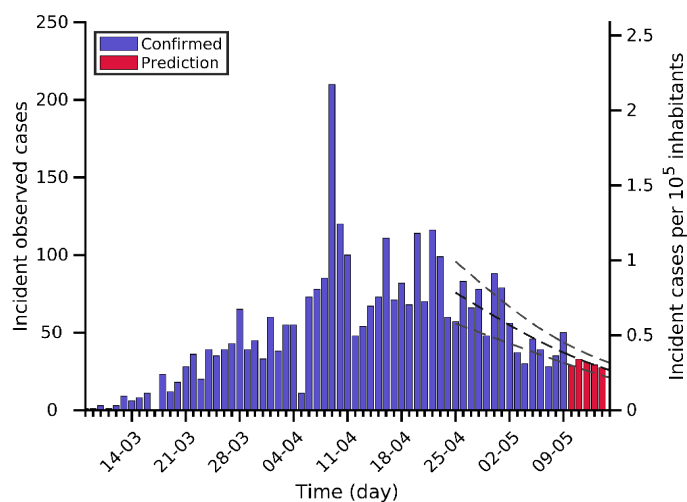
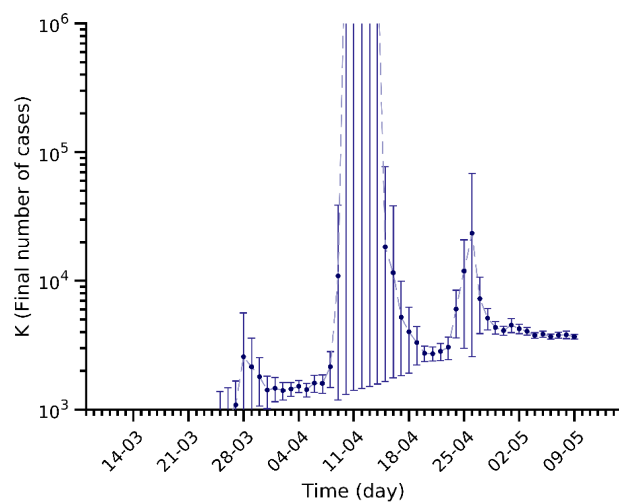
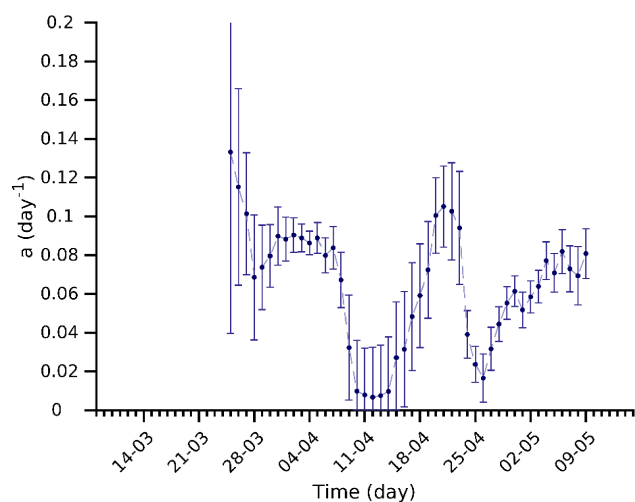
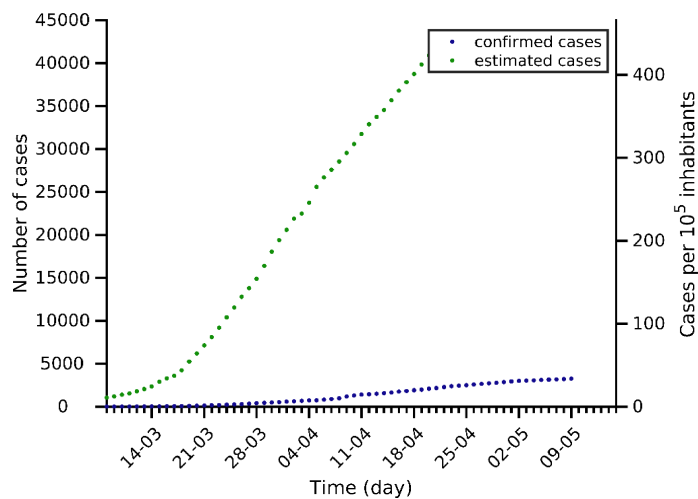
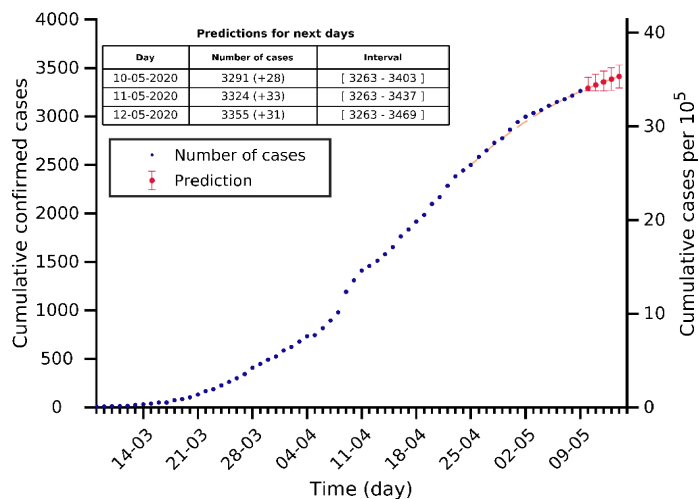
Finland 09-05-2020. Population: 5.5M. Current cumulated incidence: 106/10⁵



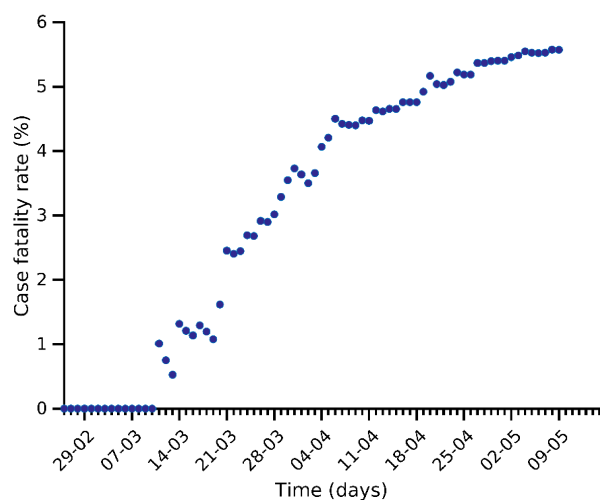
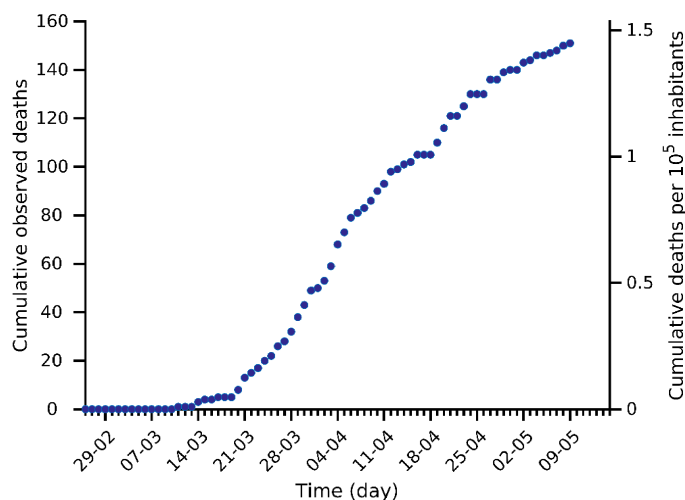
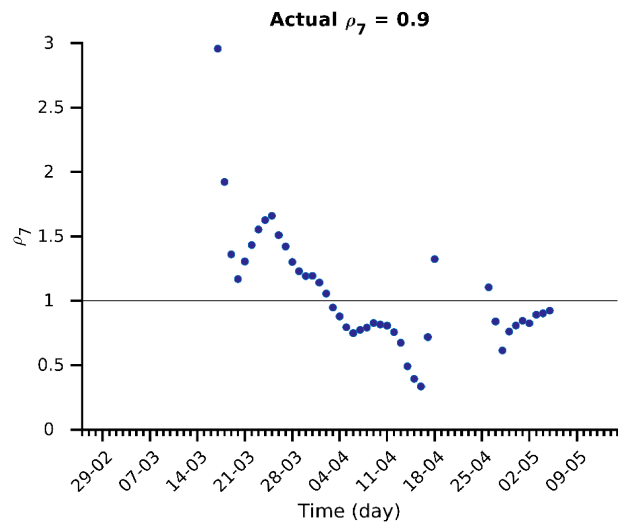
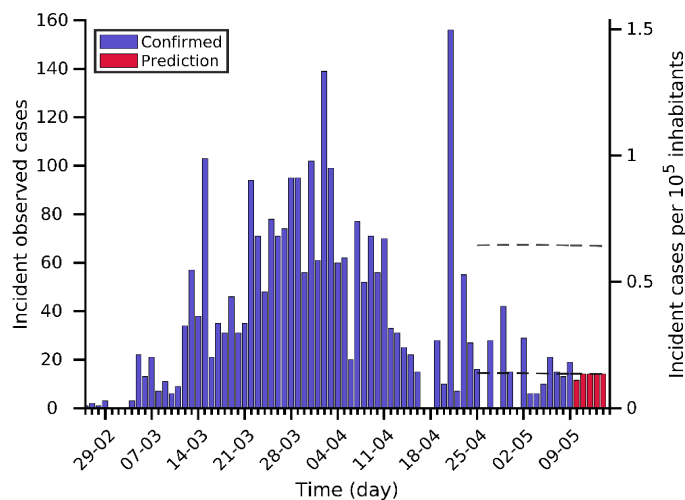
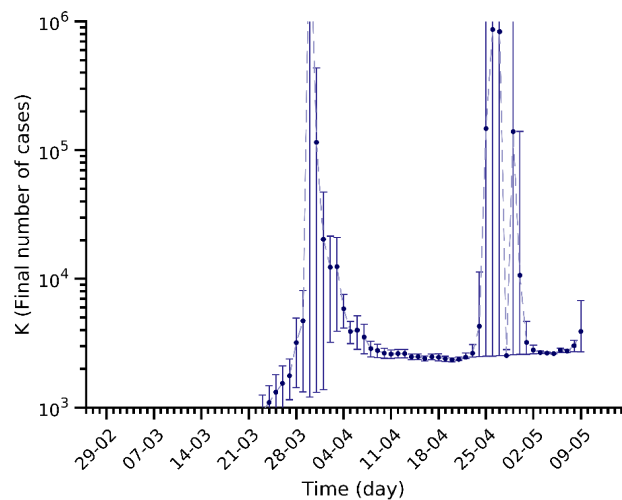
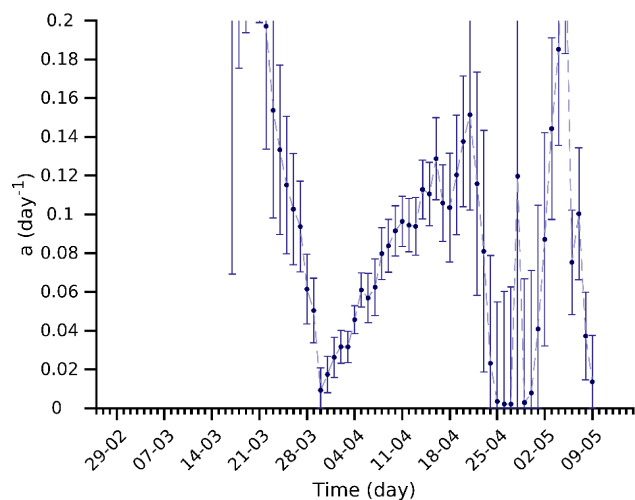
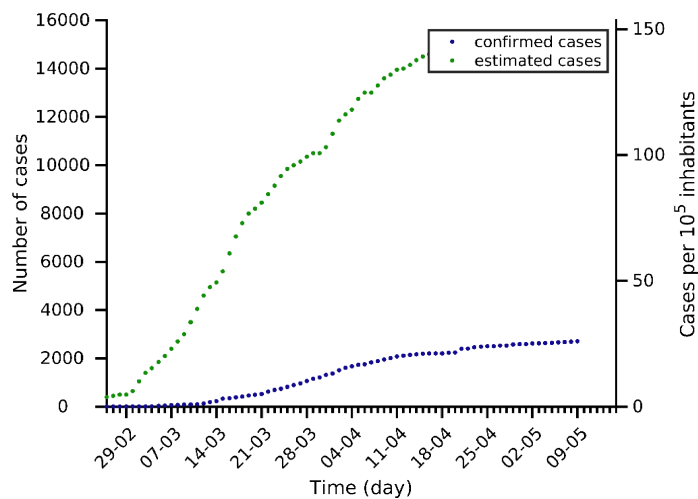
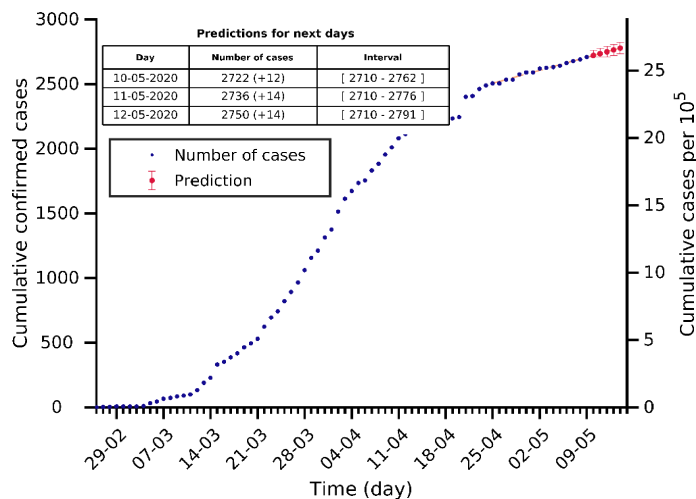
Luxembourg 09-05-2020. Population: 0.6M. Current cumulated incidence: 619/10⁵



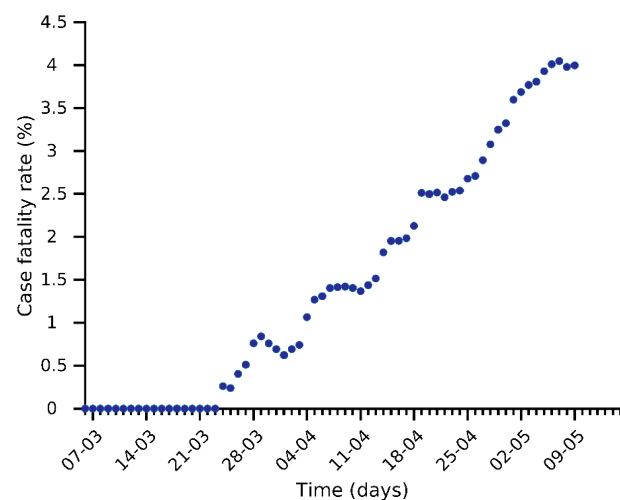
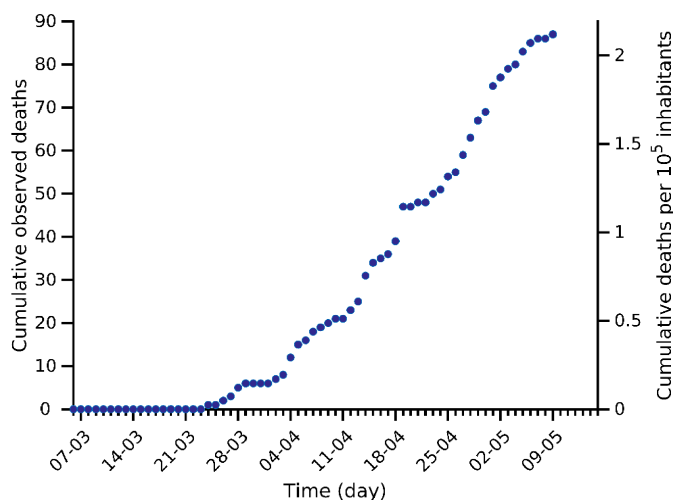
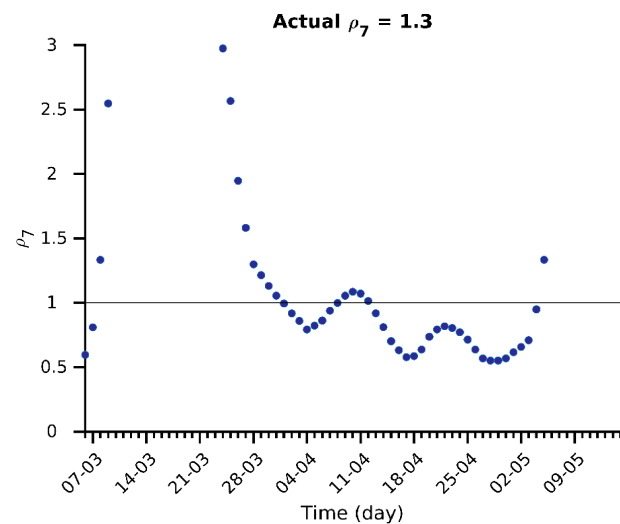
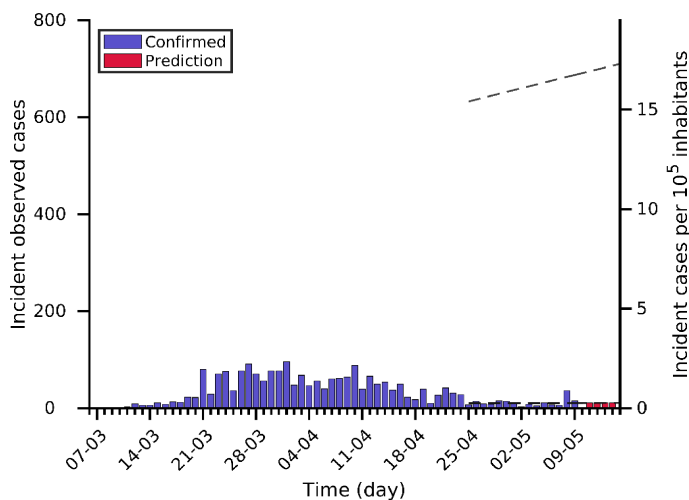
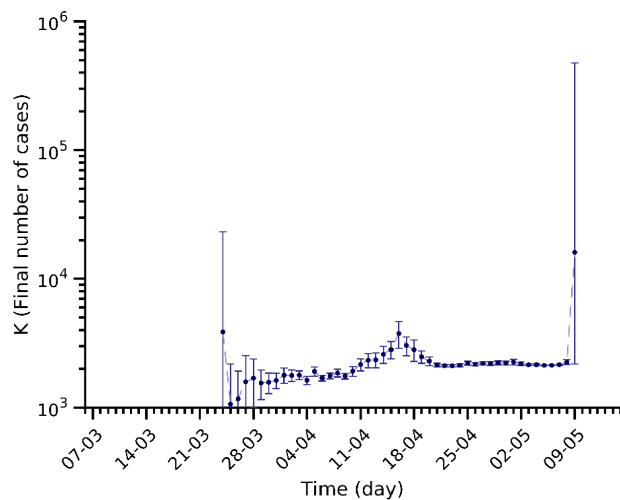
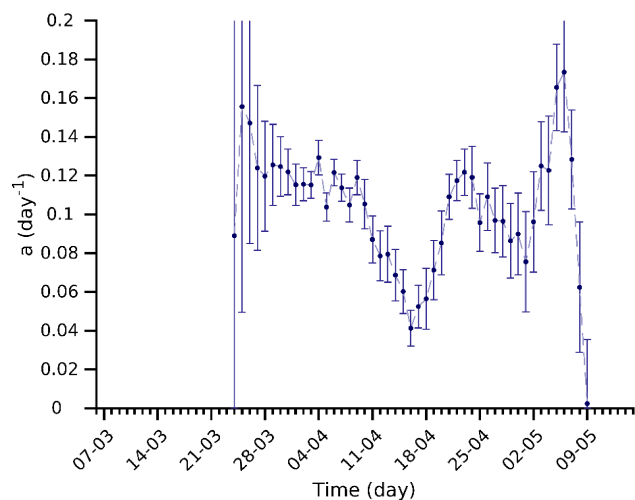
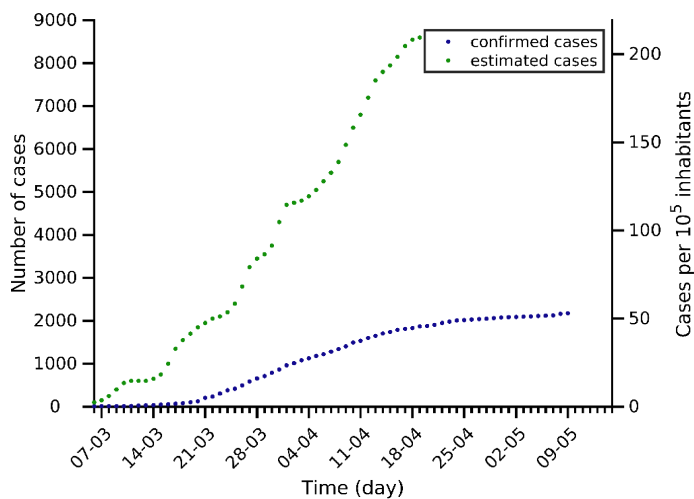
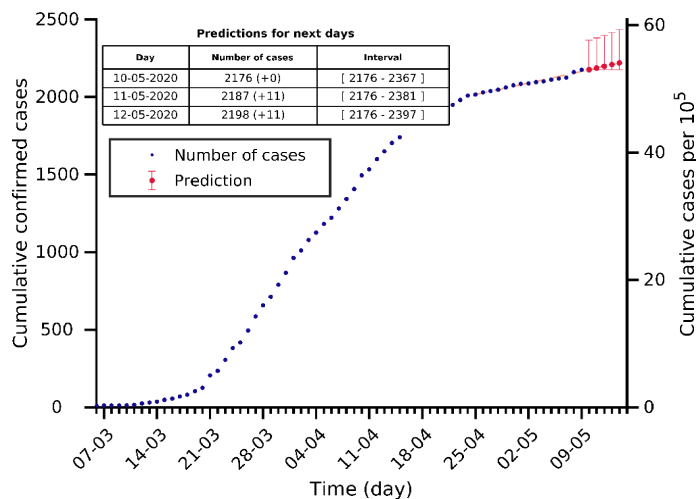
Hungary 09-05-2020. Population: 9.7M. Current cumulated incidence: 34/10⁵



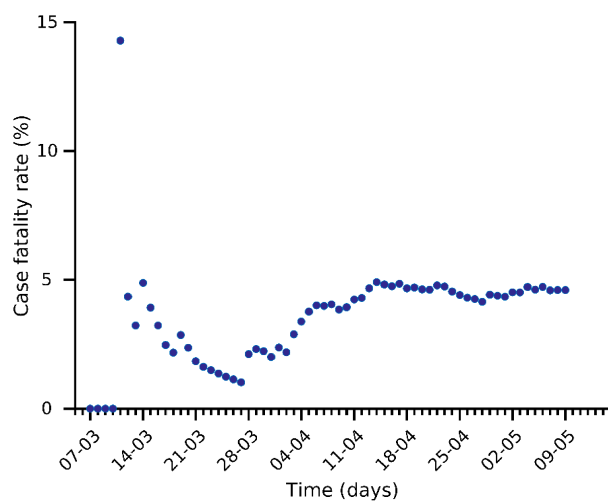
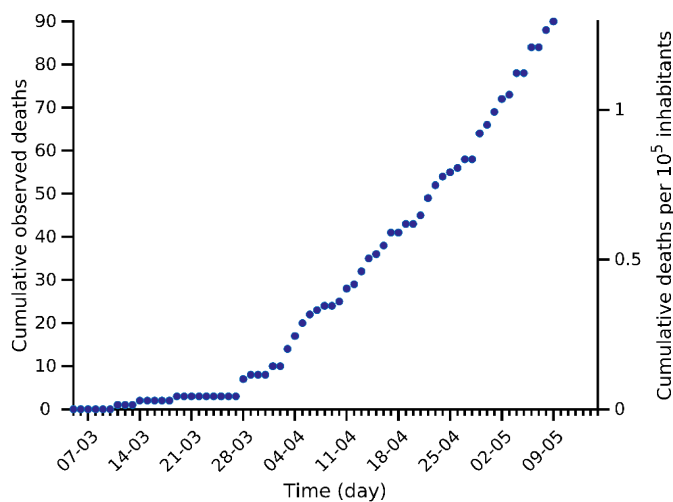
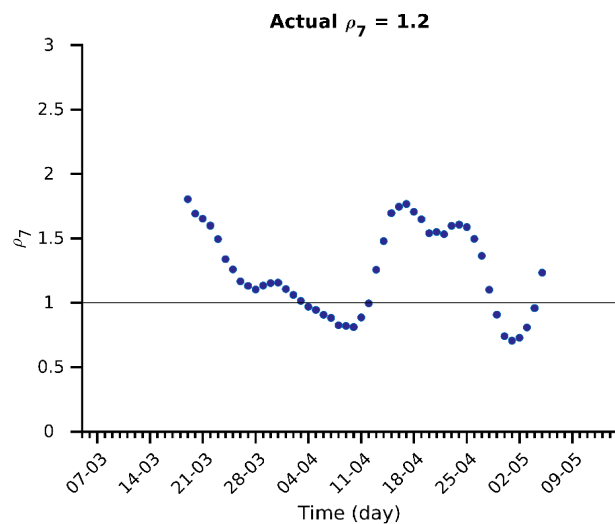
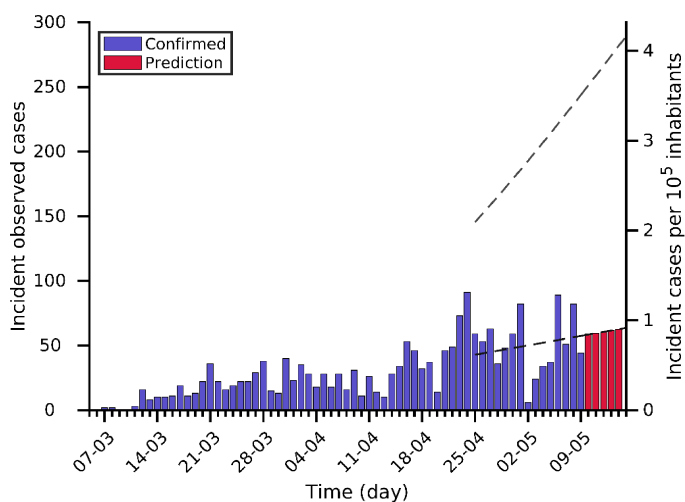
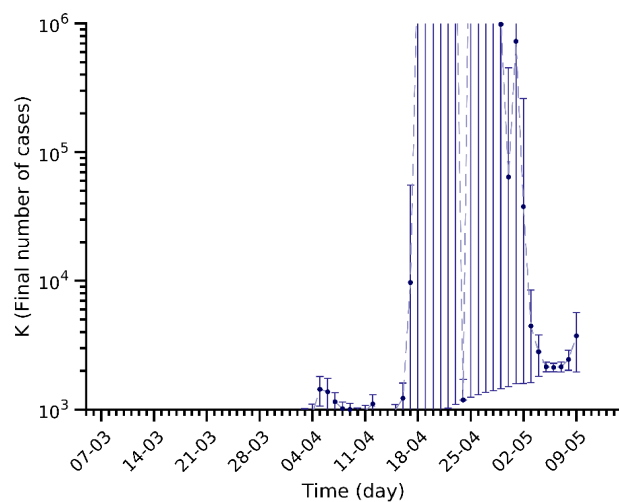
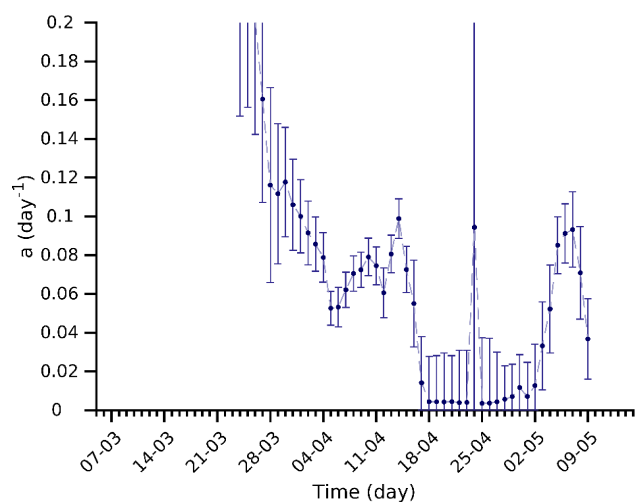
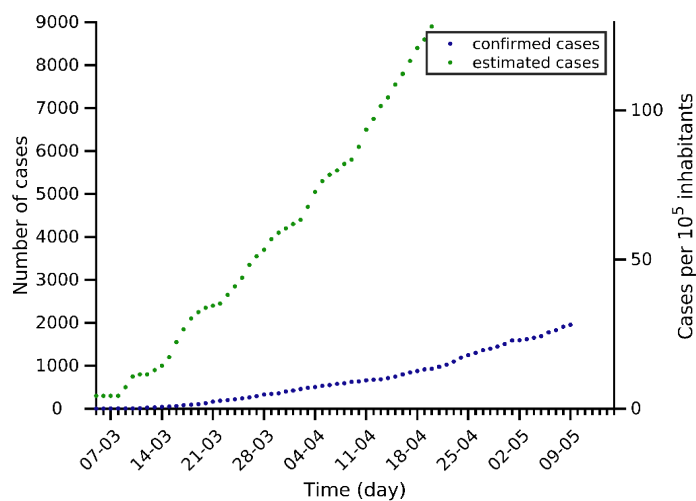
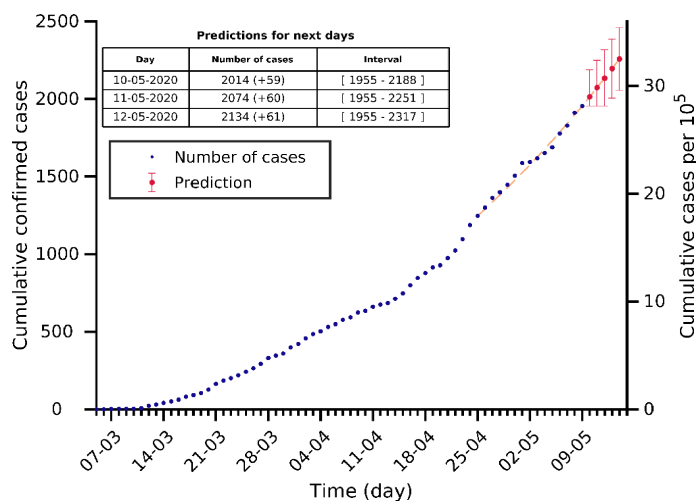
Greece 09-05-2020. Population: 10.4M. Current cumulated incidence: 26/10⁵



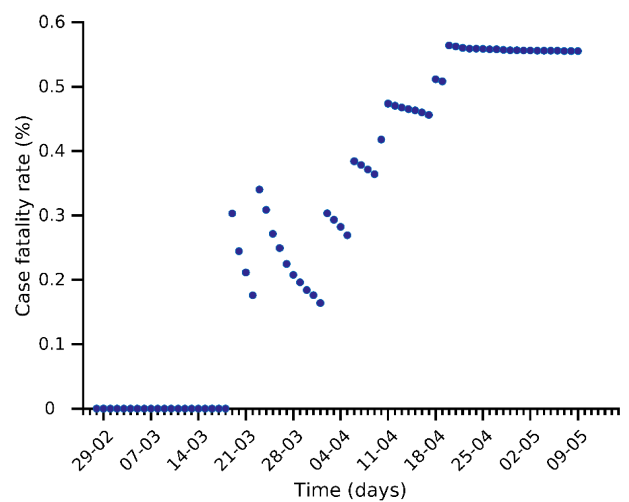
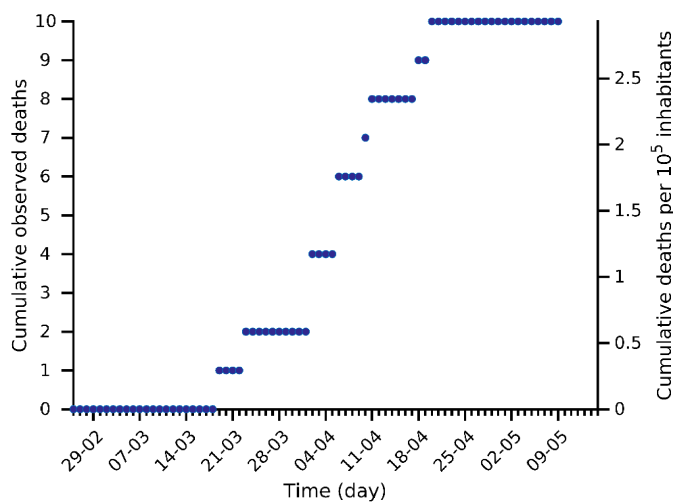
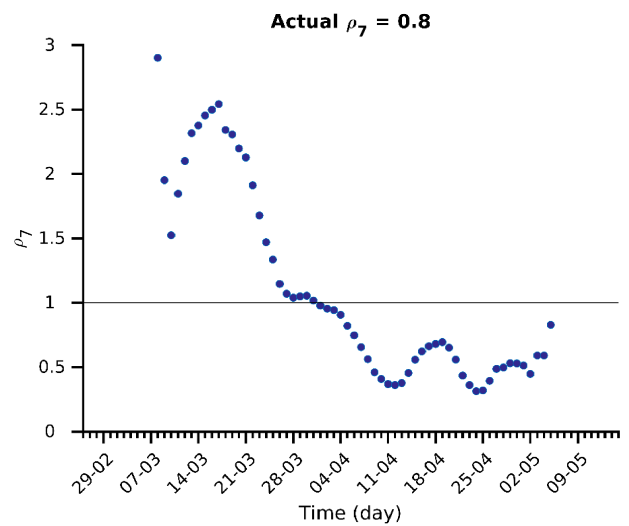
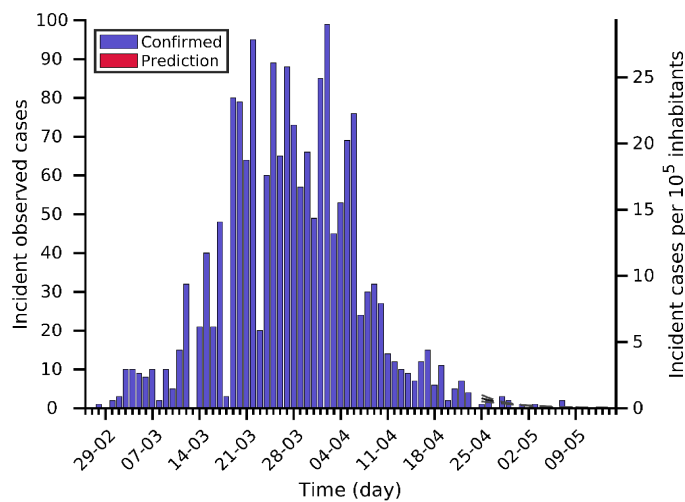
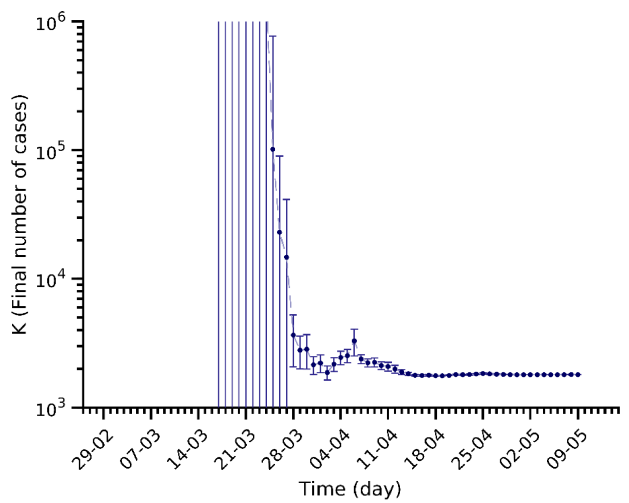
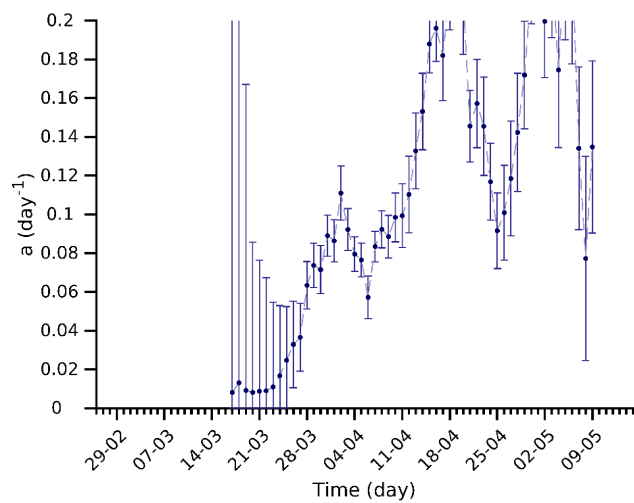
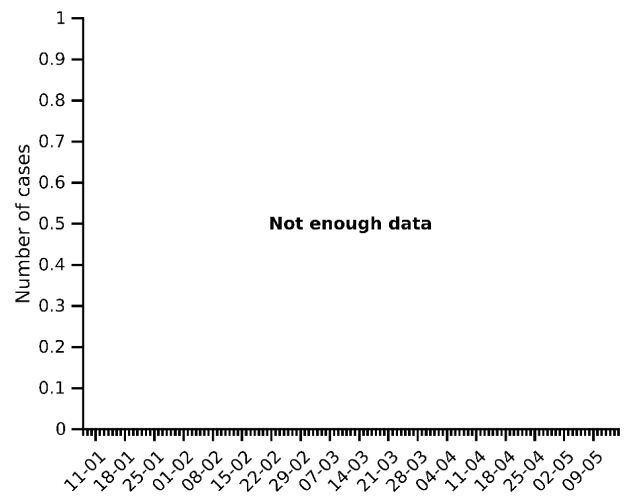
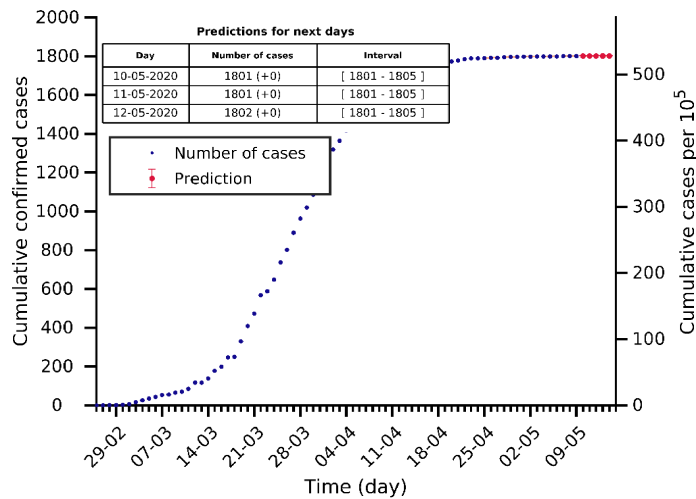
Croatia 09-05-2020. Population: 4.1M. Current cumulated incidence: 53/10⁵



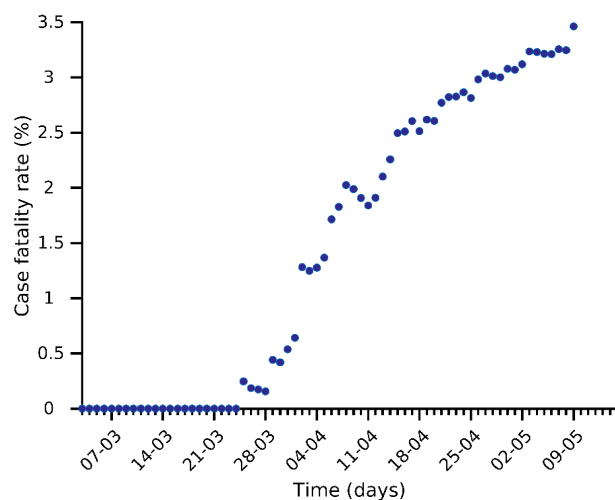
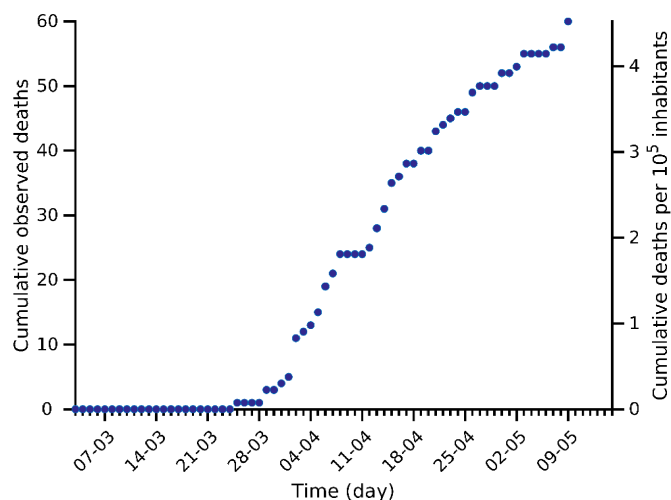
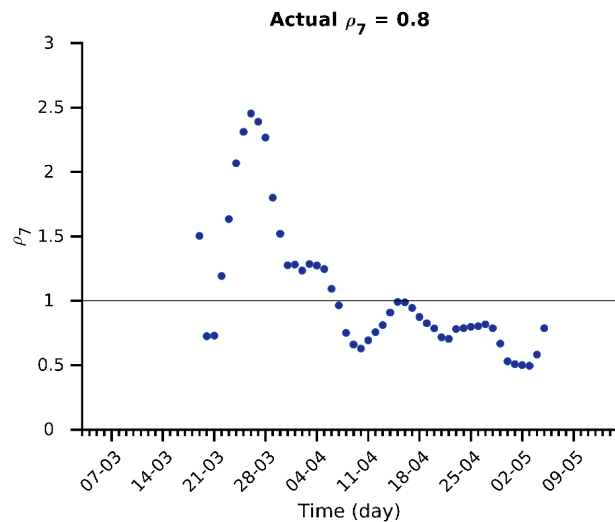
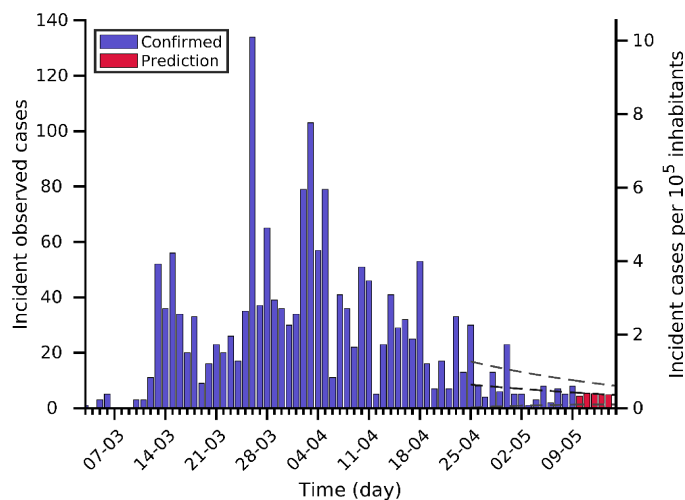
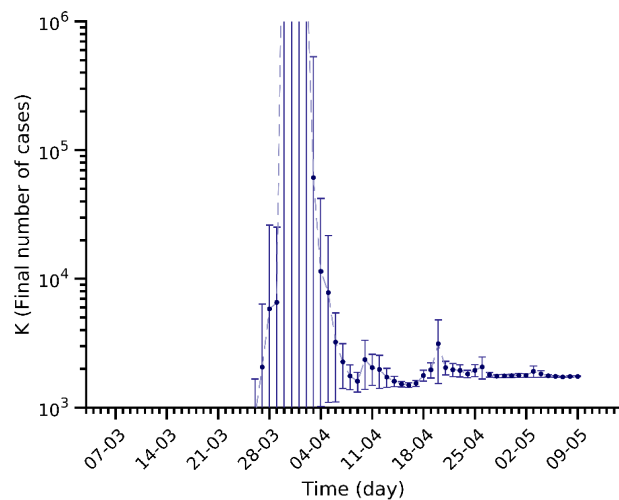
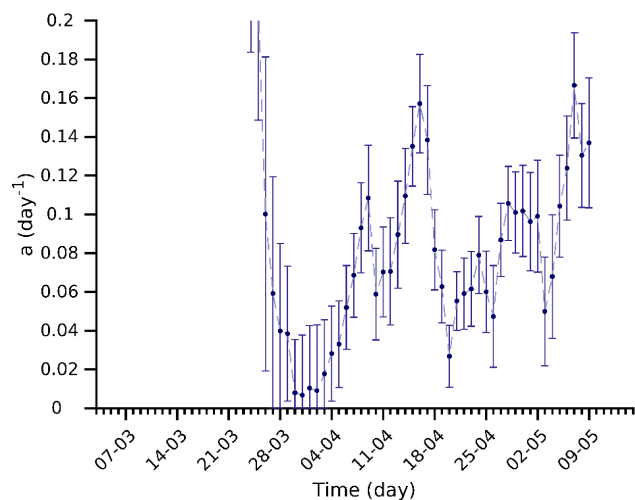
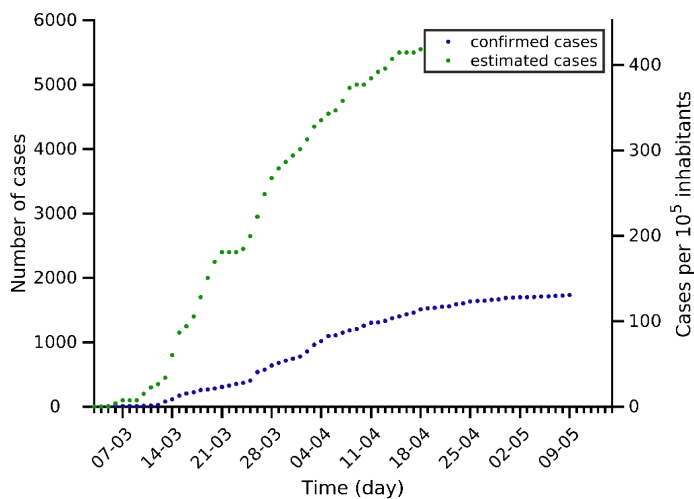
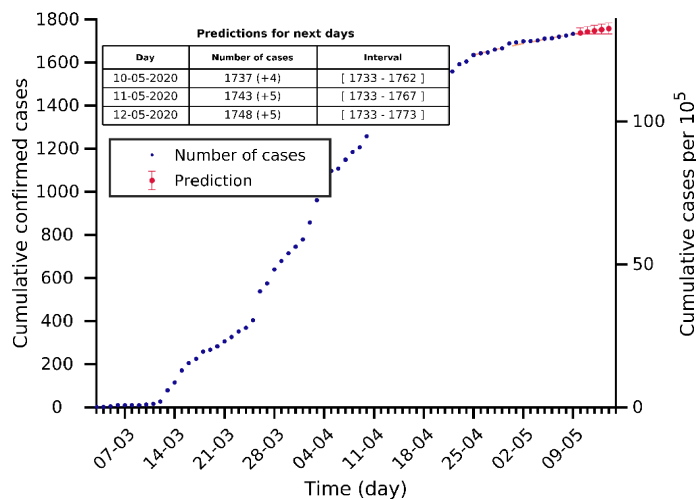
Bulgaria 09-05-2020. Population: 6.9M. Current cumulated incidence: 28/10⁵



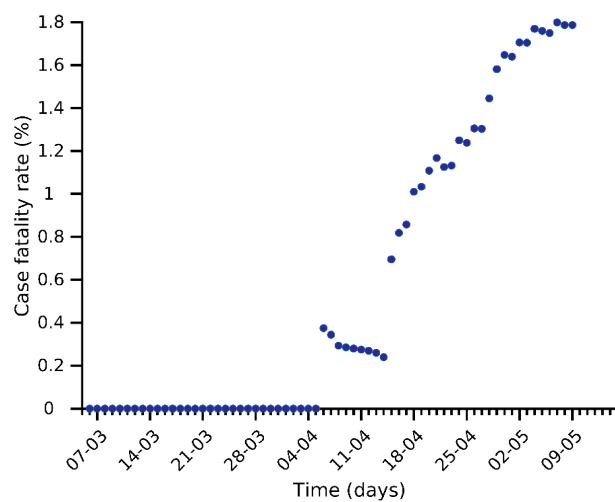
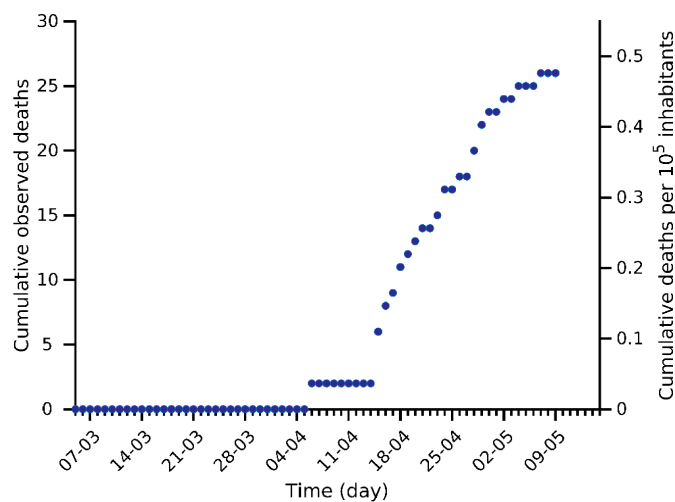
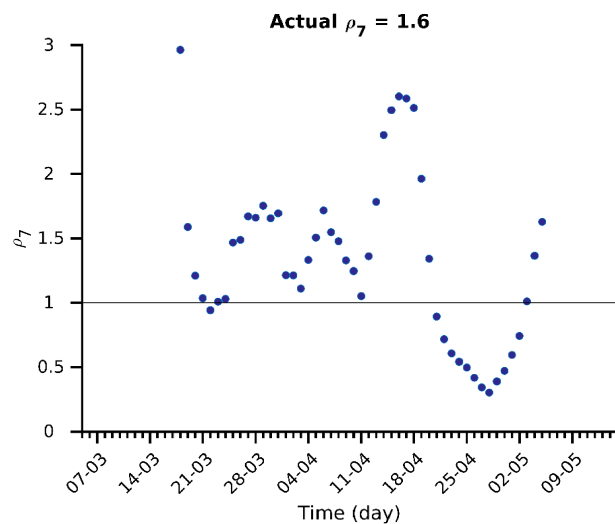
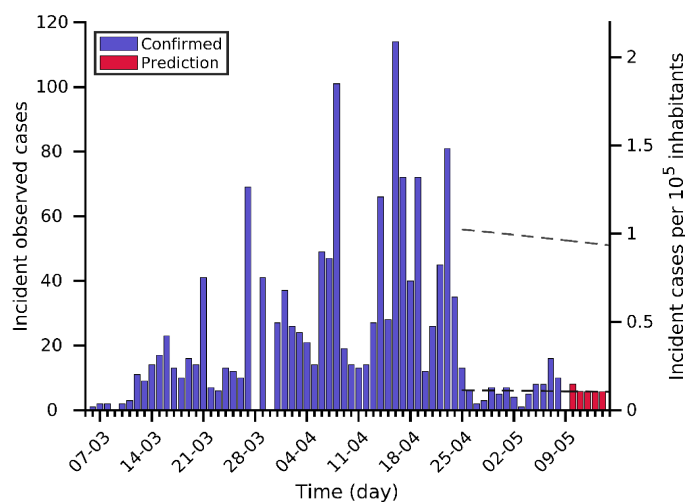
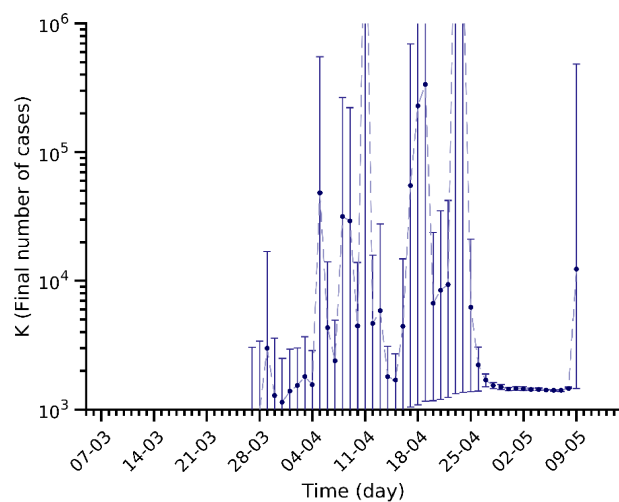
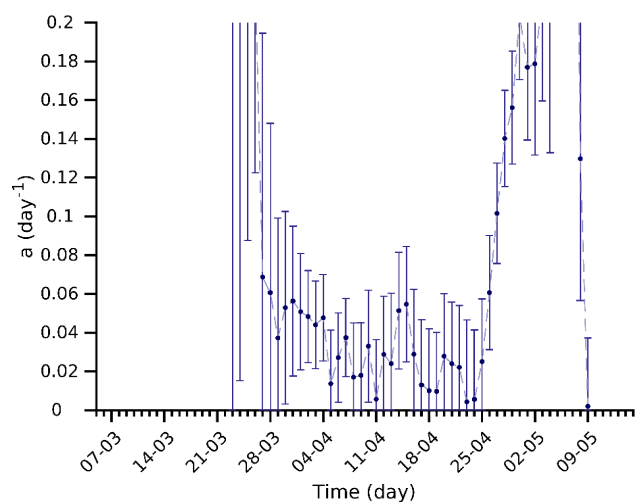
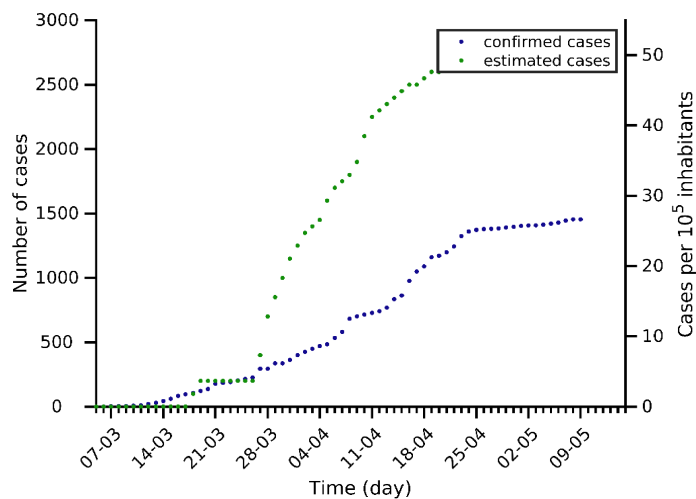
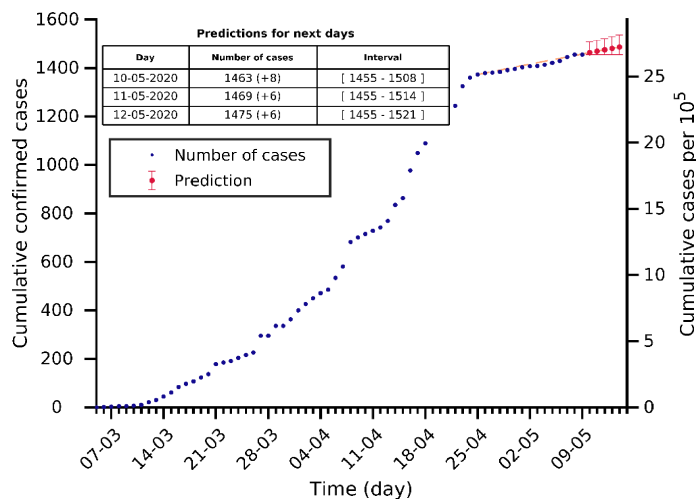
Iceland 09-05-2020. Population: 0.3M. Current cumulated incidence: 528/10⁵



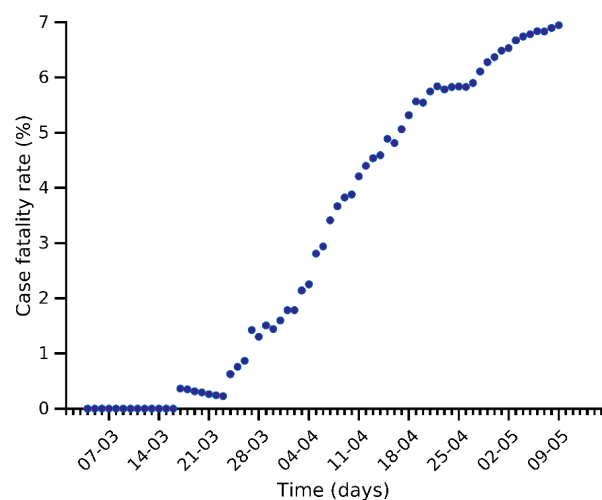
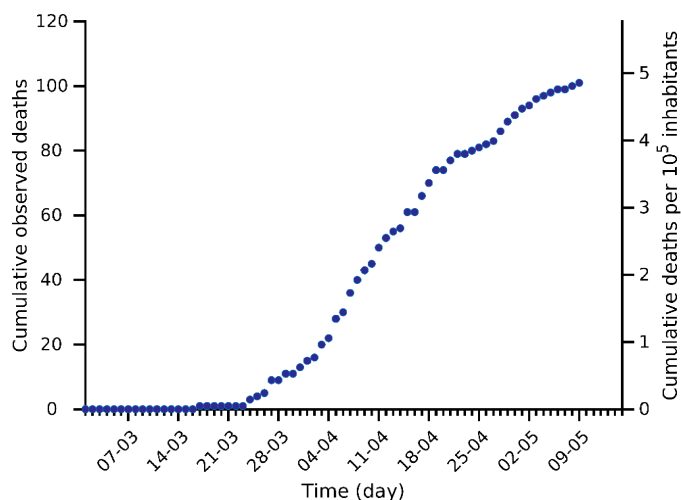
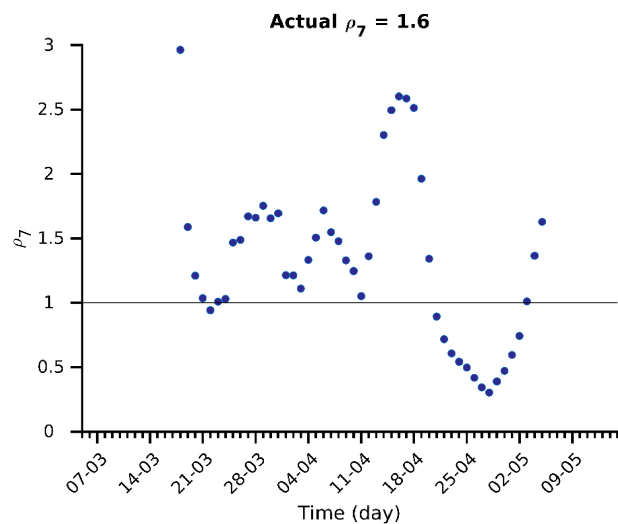
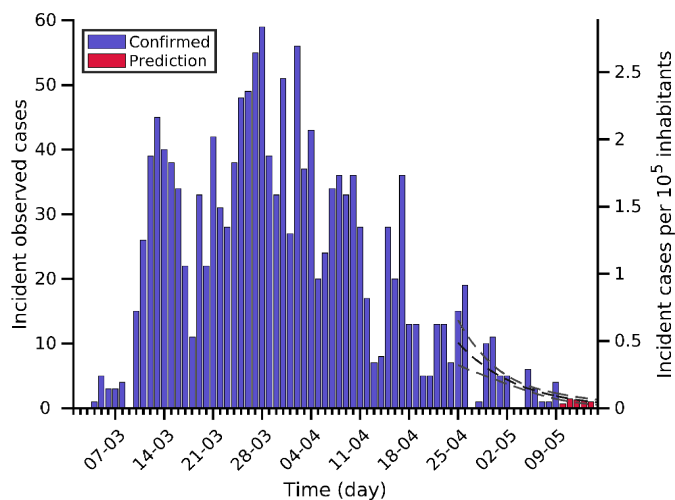
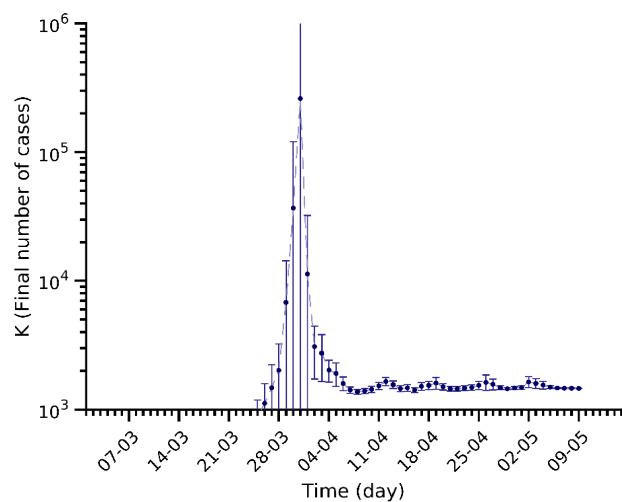
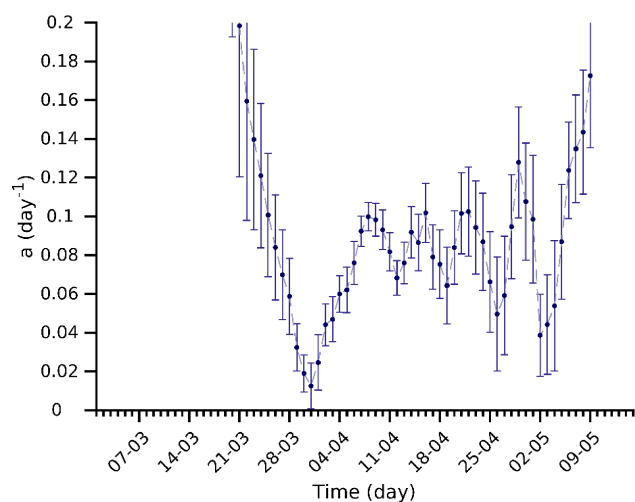
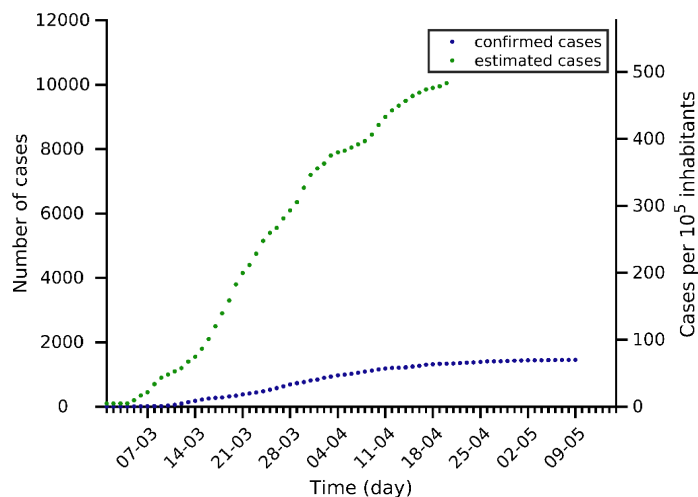
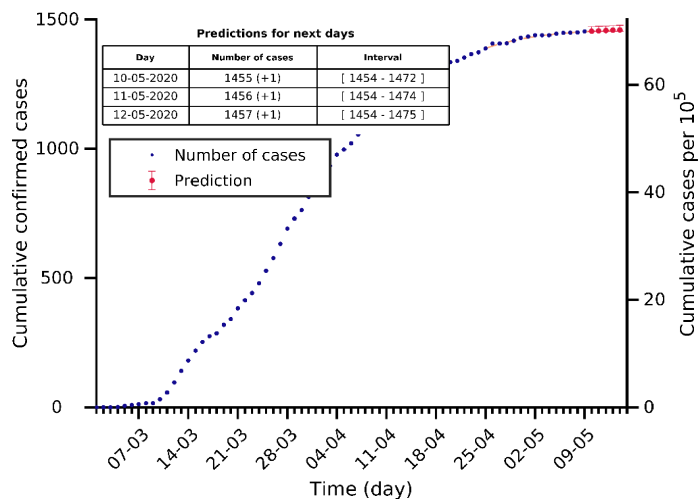
Estonia 09-05-2020. Population: 1.3M. Current cumulated incidence: 131/10⁵



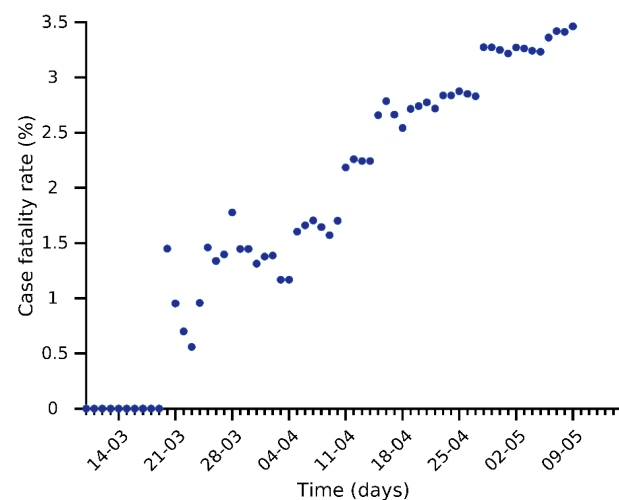
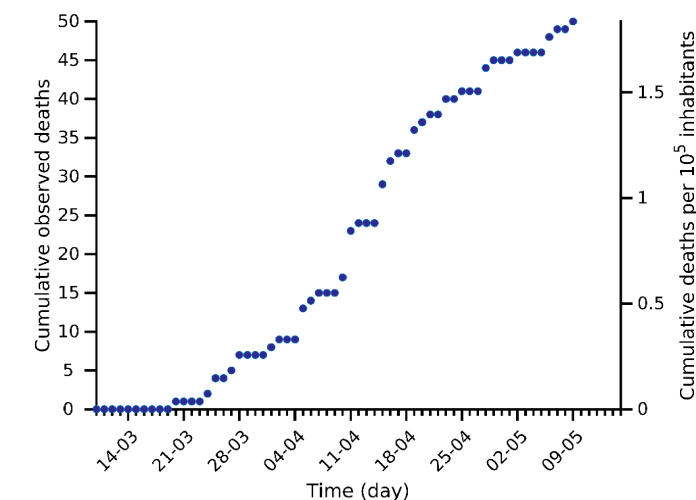
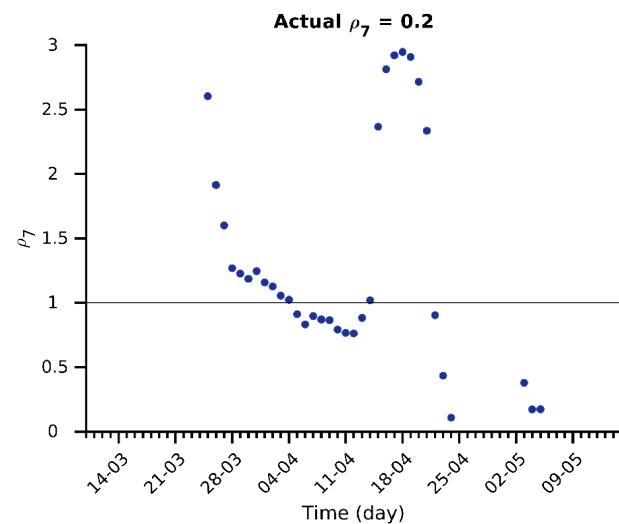
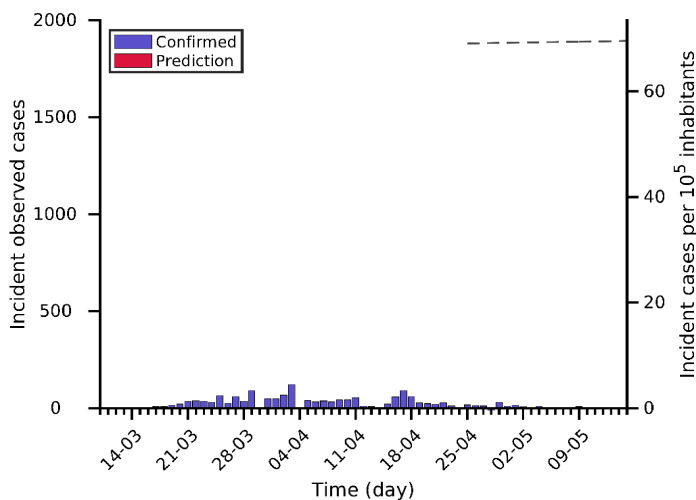
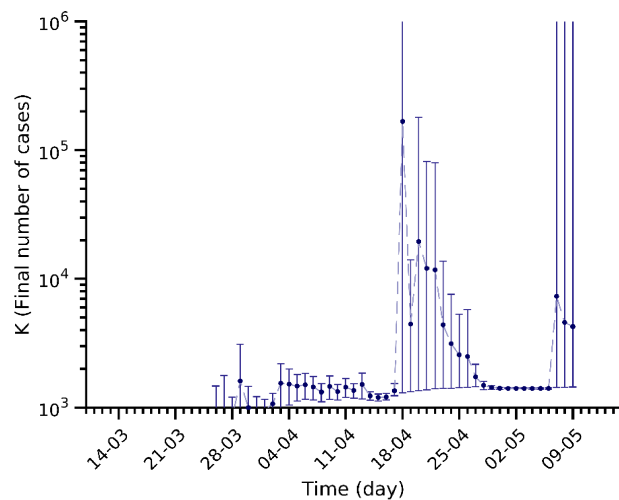
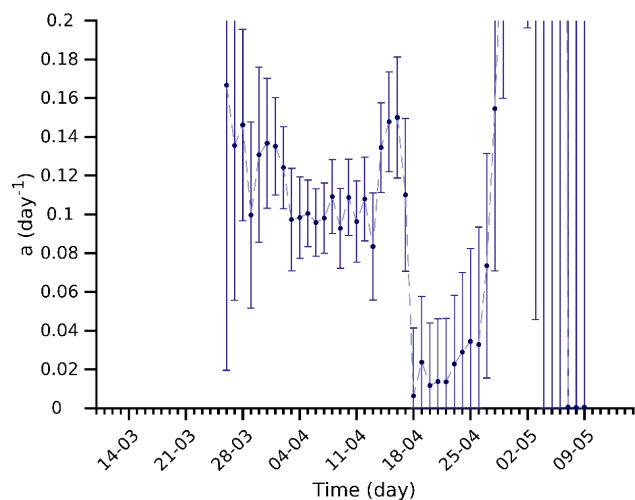
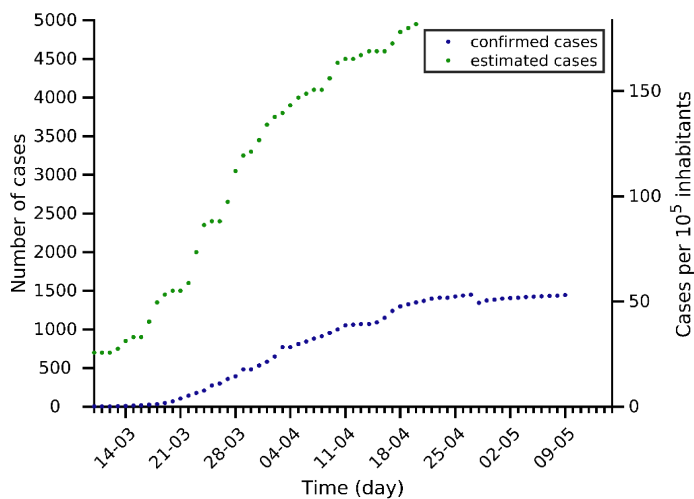
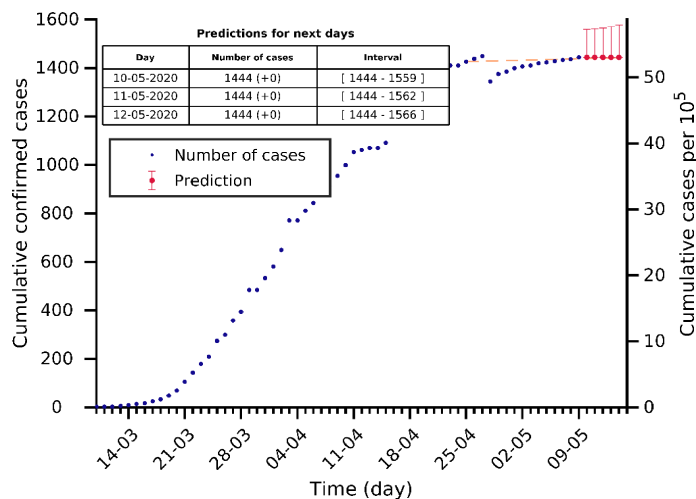
Slovakia 09-05-2020. Population: 5.5M. Current cumulated incidence: $27/10^5$



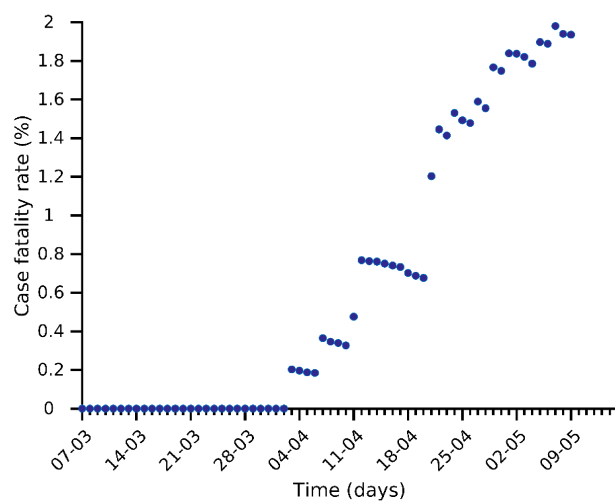
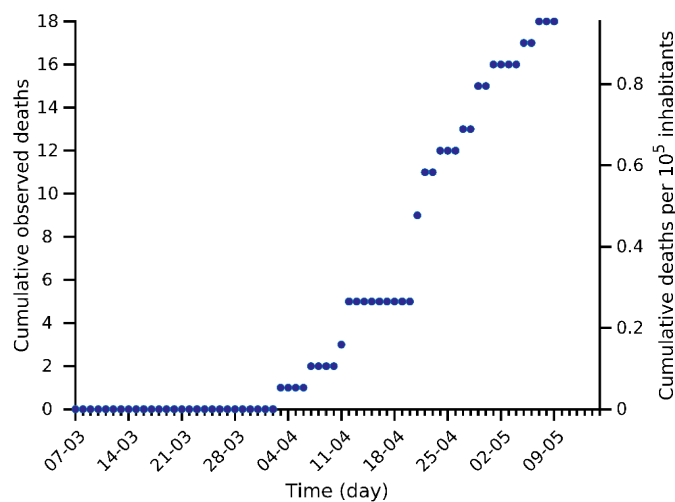
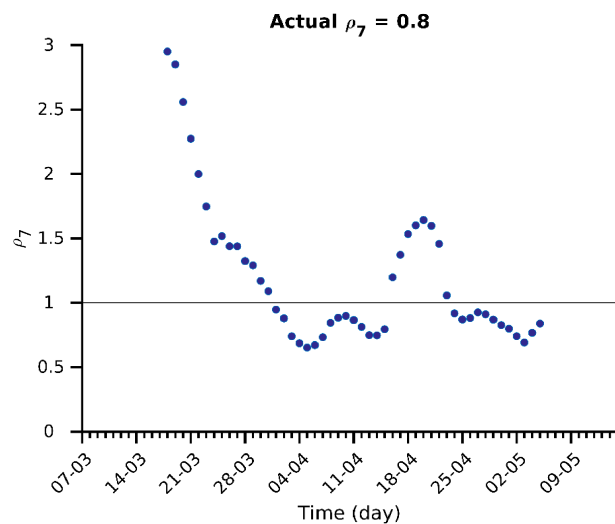
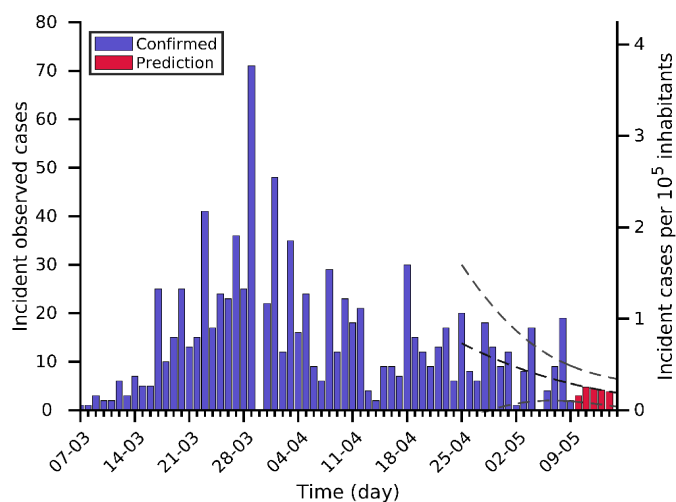
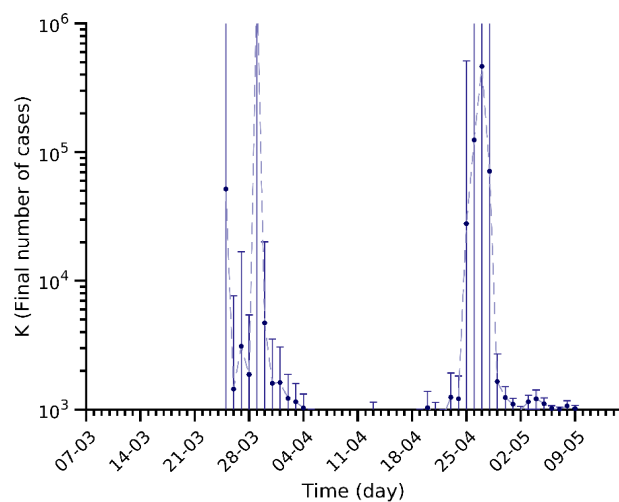
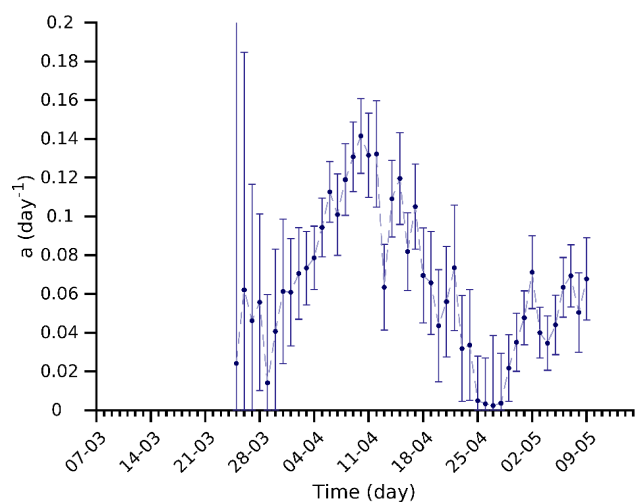
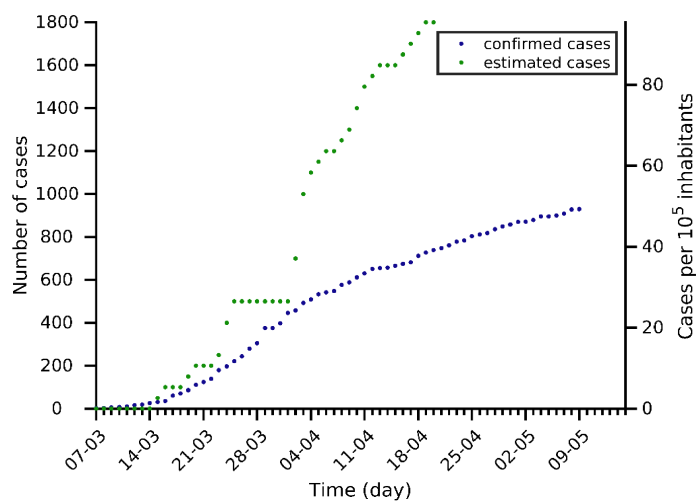
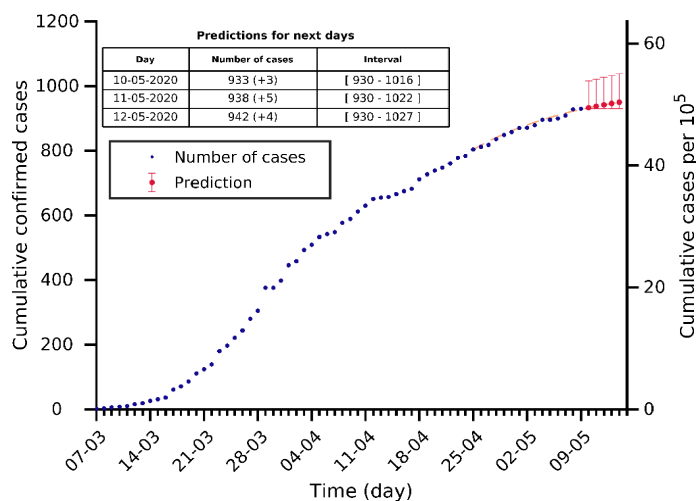
Slovenia 09-05-2020. Population: 2.1M. Current cumulated incidence: 70/10⁵



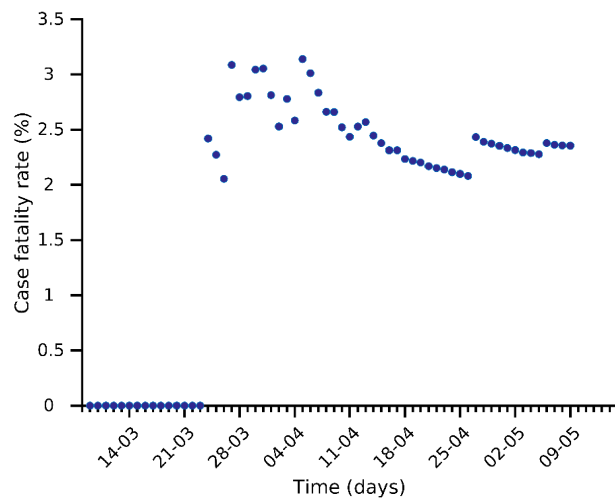
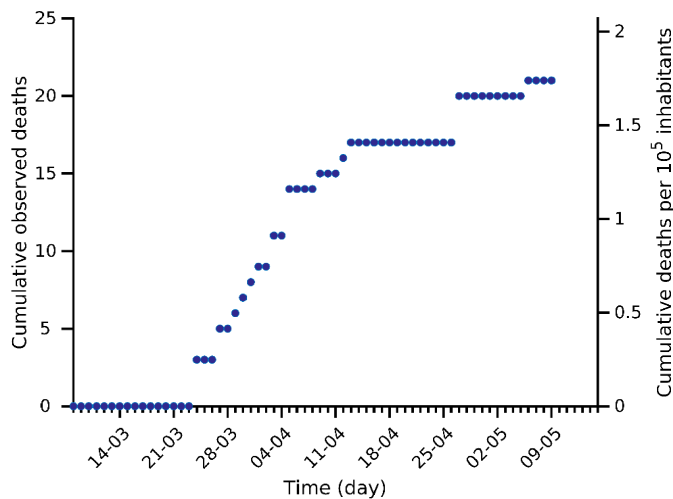
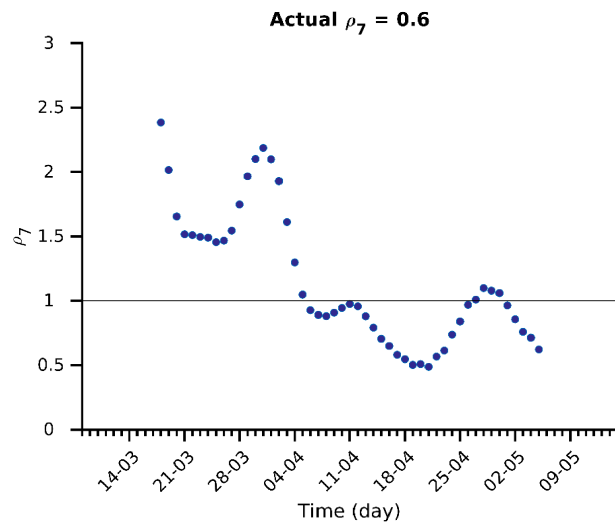
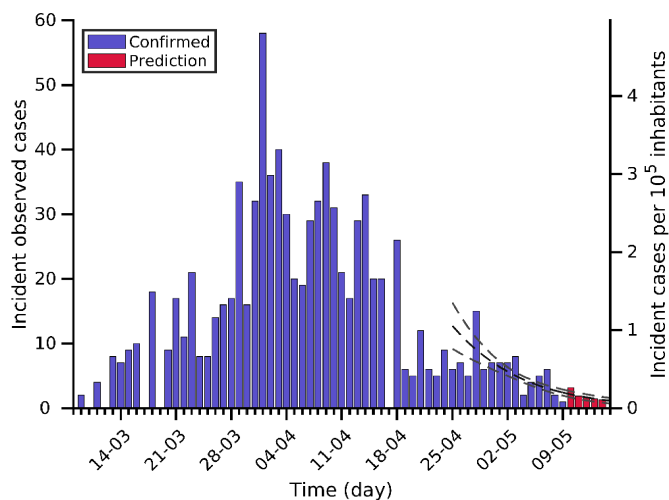
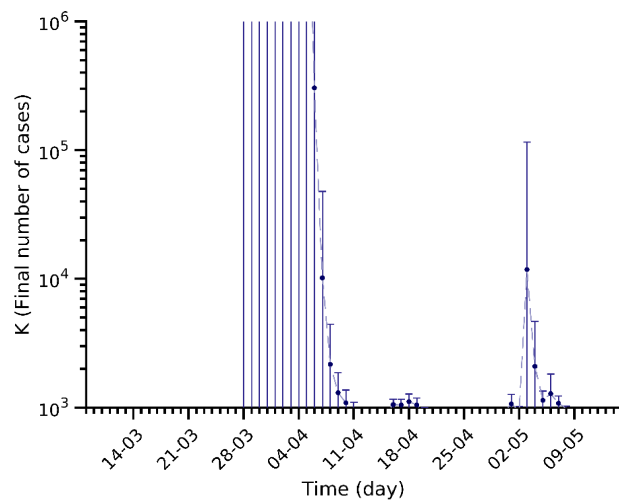
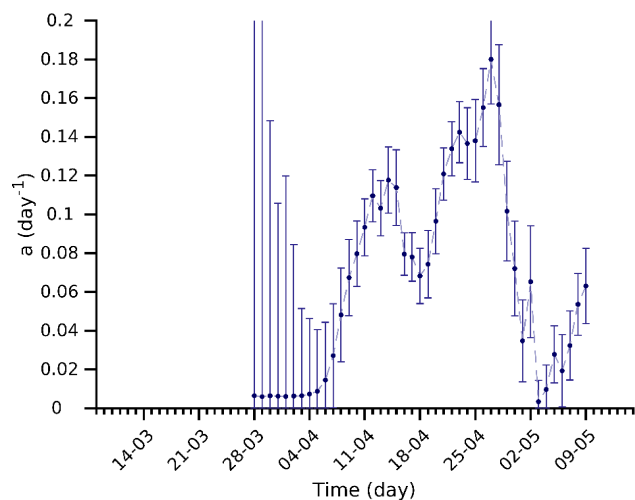
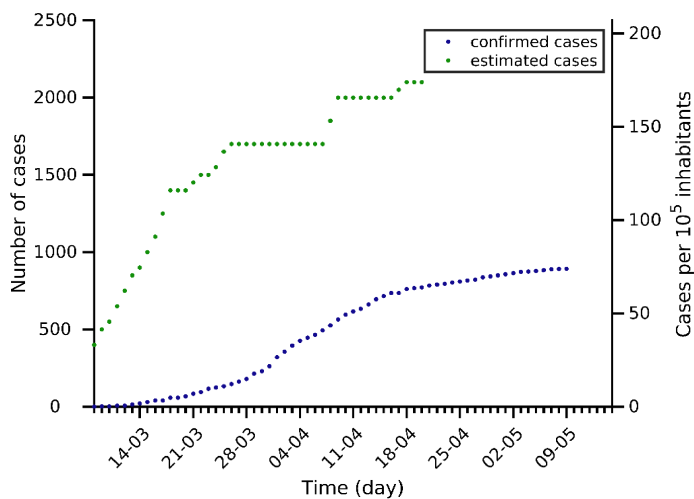
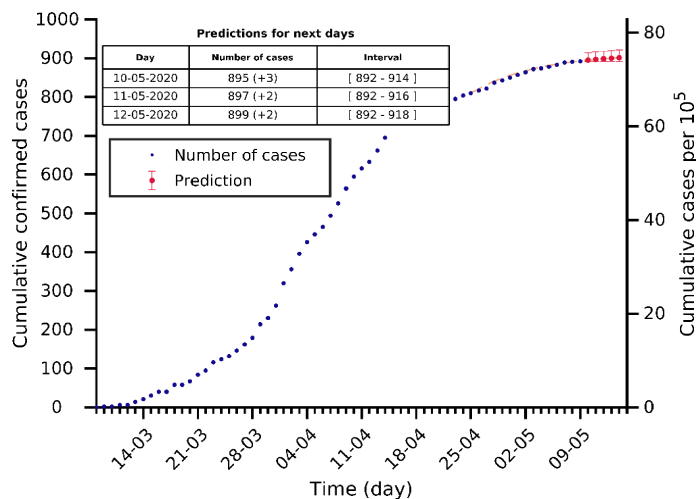
Lithuania 09-05-2020. Population: 2.7M. Current cumulated incidence: 53/10⁵



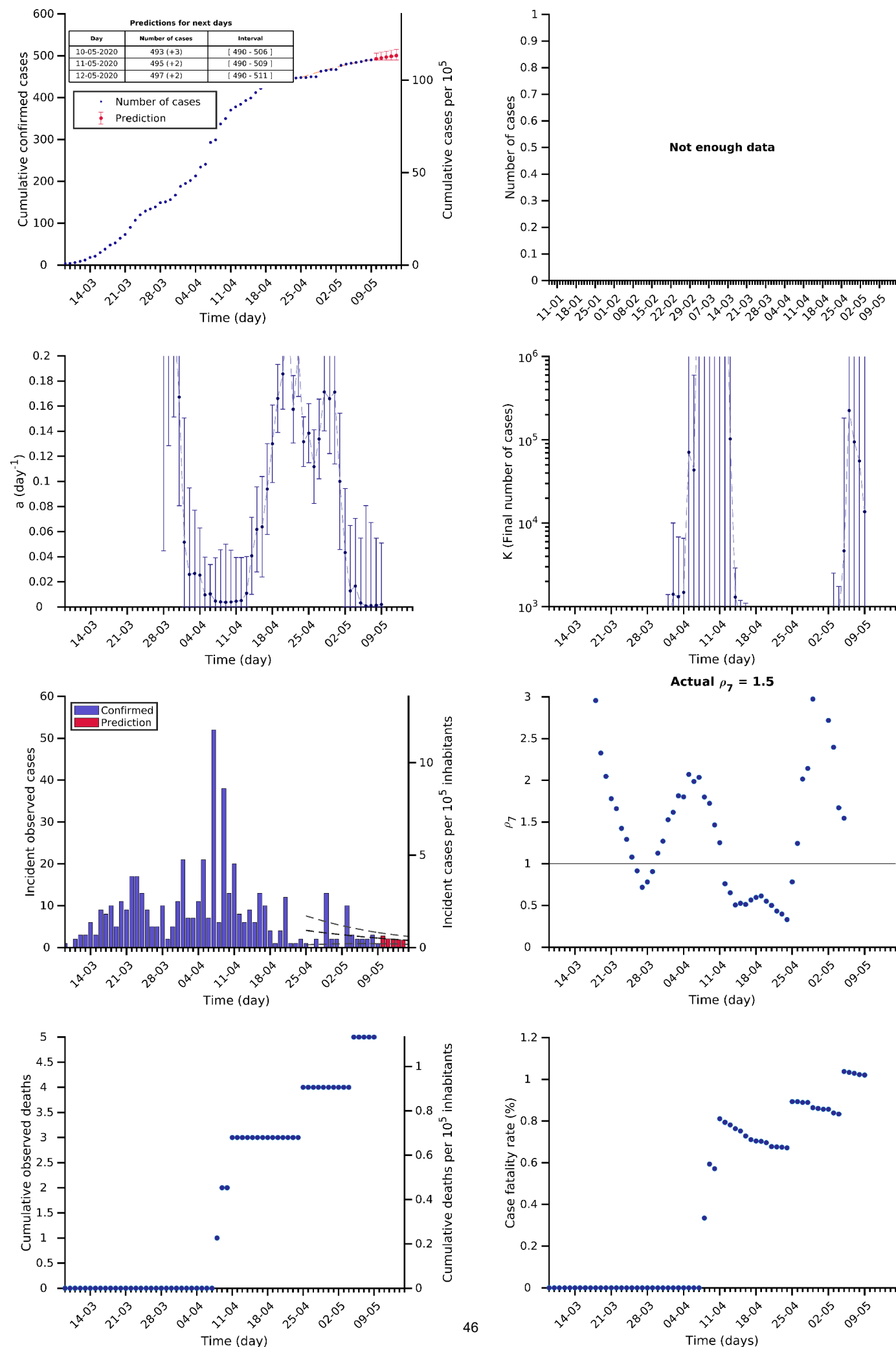
Latvia 09-05-2020. Population: 1.9M. Current cumulated incidence: 49/10⁵



Cyprus 09-05-2020. Population: 1.2M. Current cumulated incidence: 74/10⁵



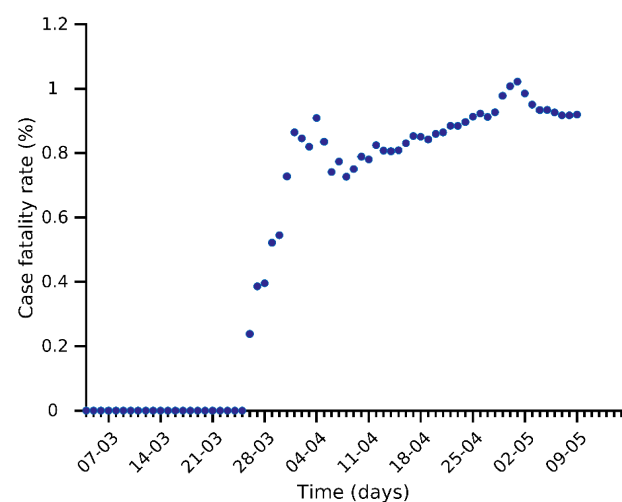
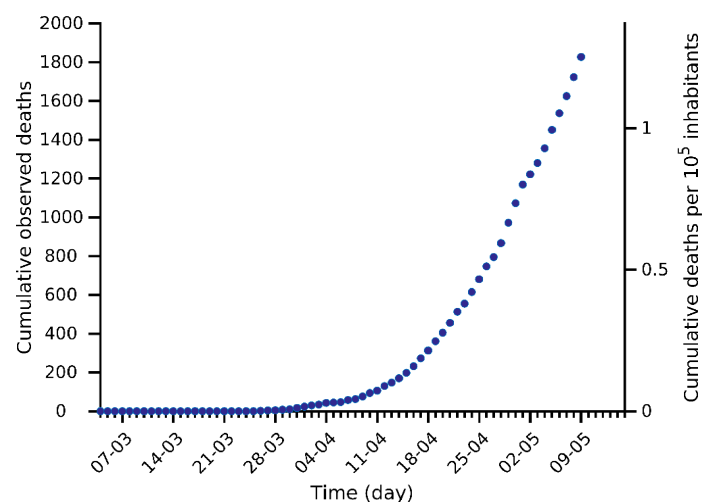
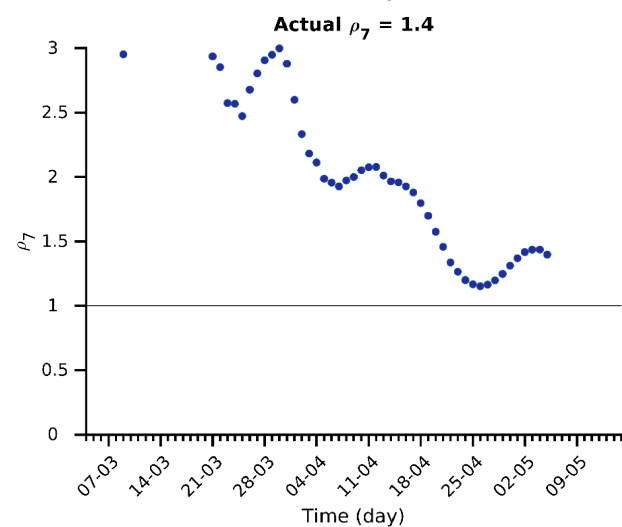
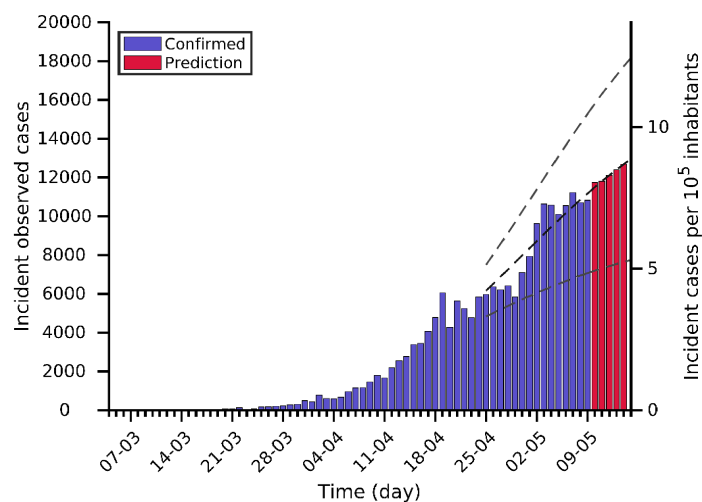
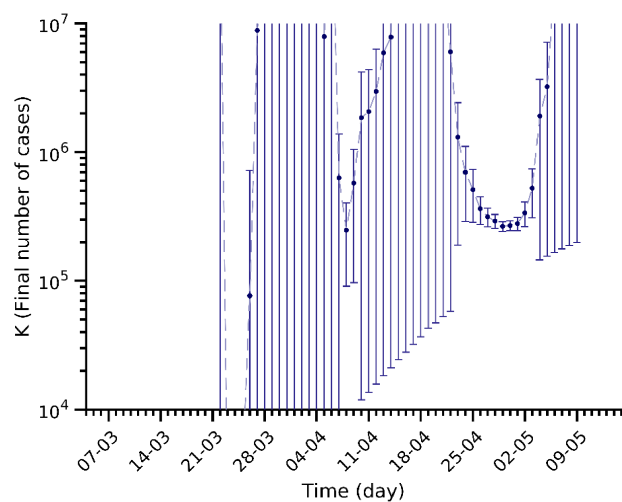
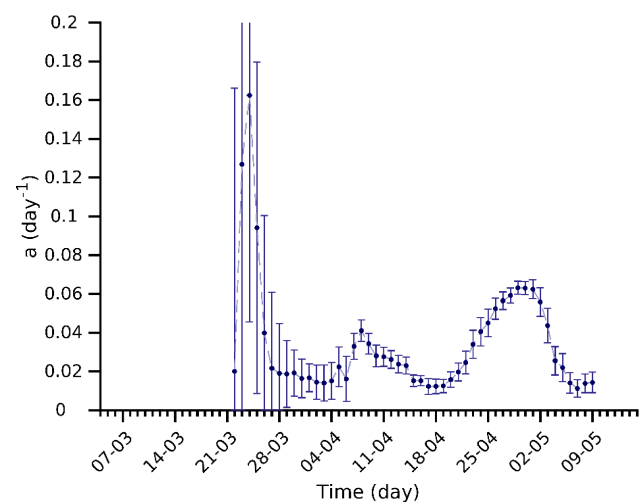
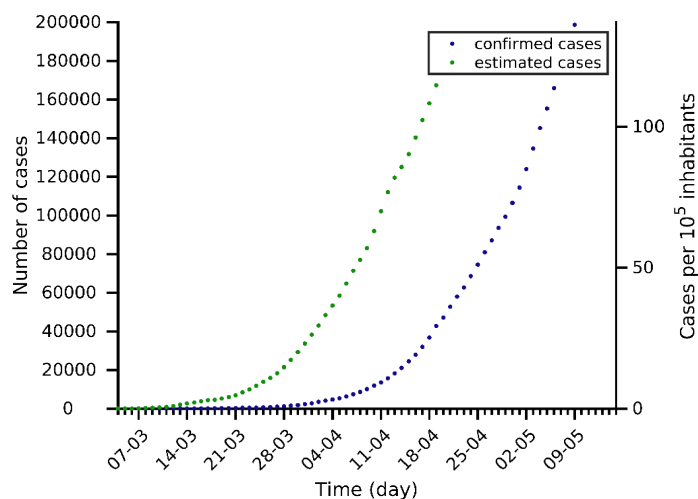
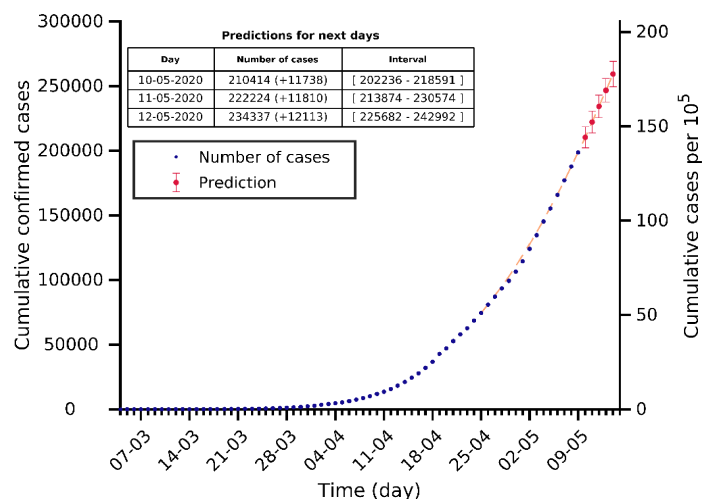
Malta 09-05-2020. Population: 0.4M. Current cumulated incidence: 111/10⁵



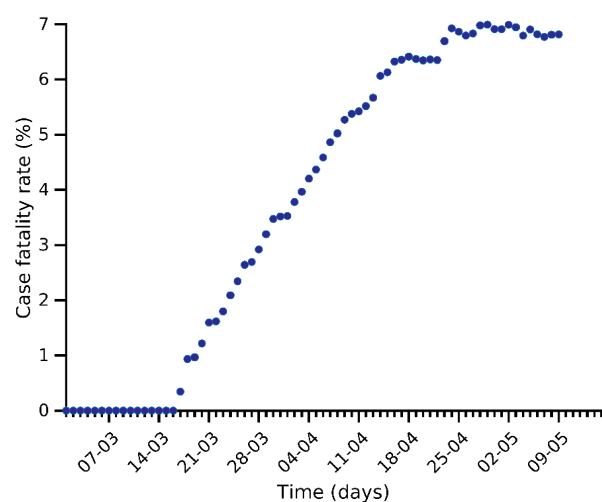
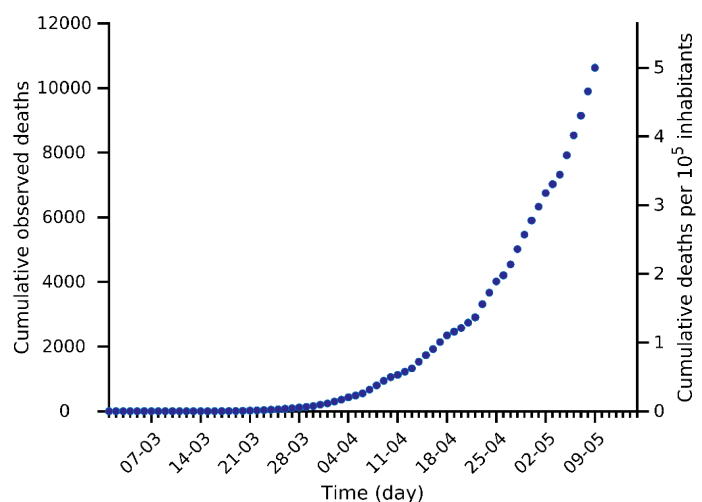
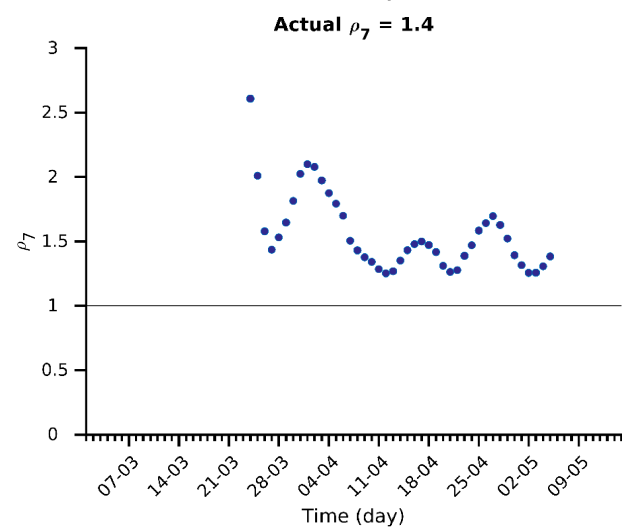
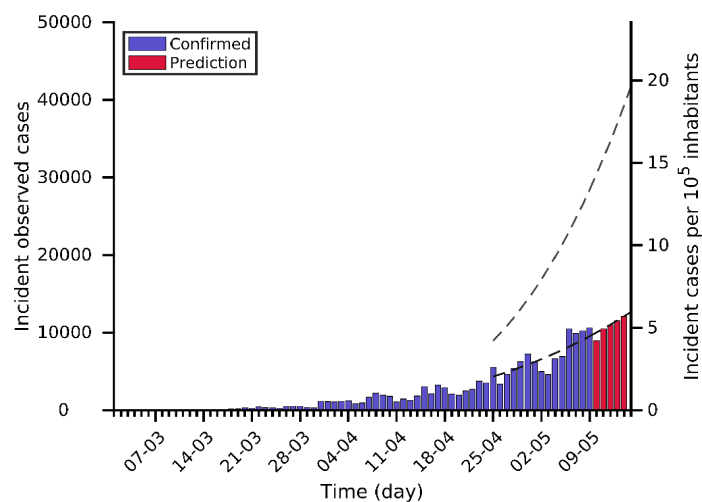
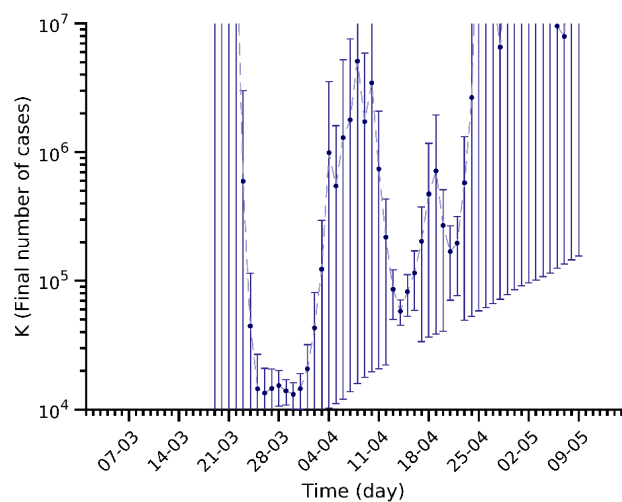
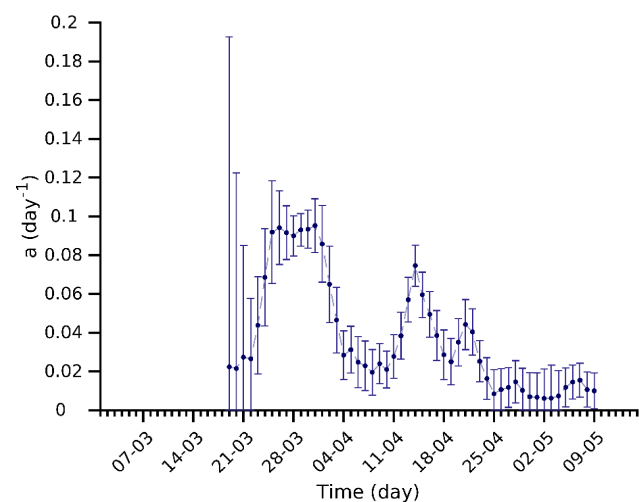
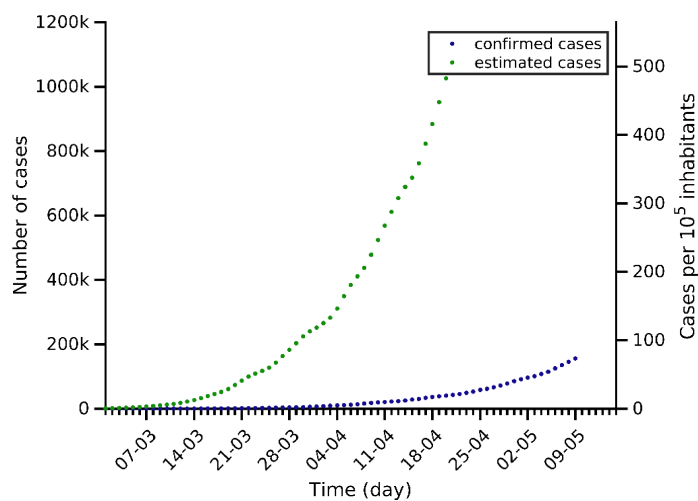
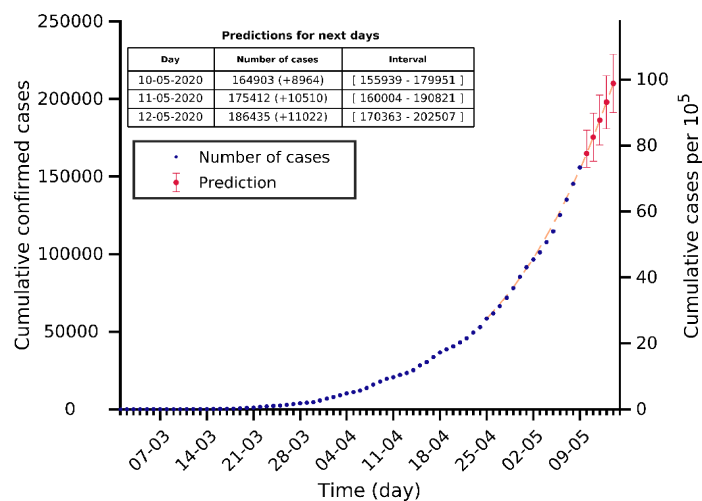
(2) Analysis and prediction of COVID-19 for other countries

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

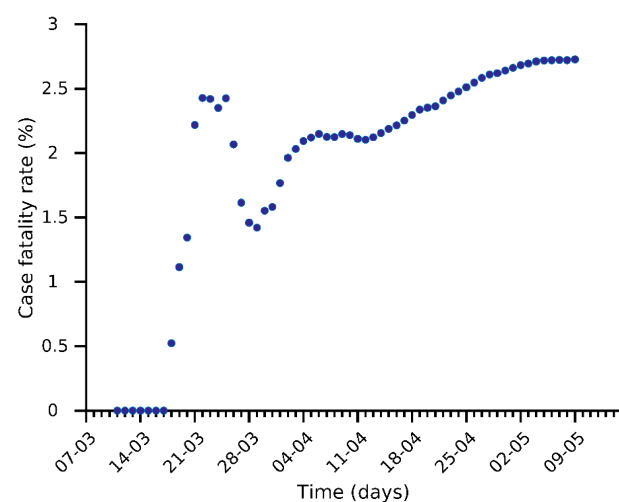
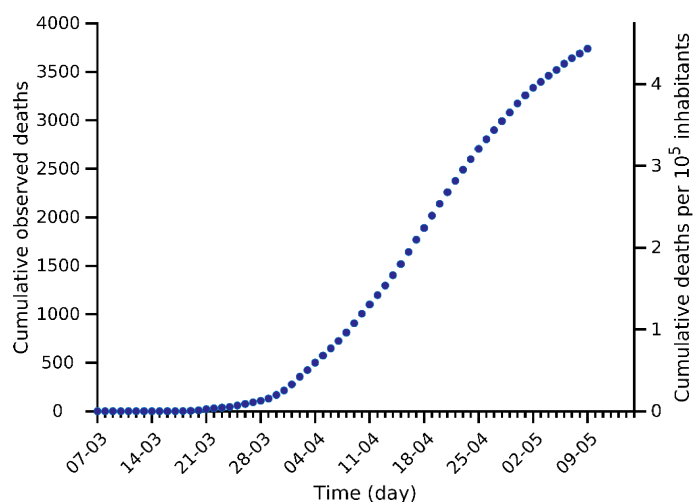
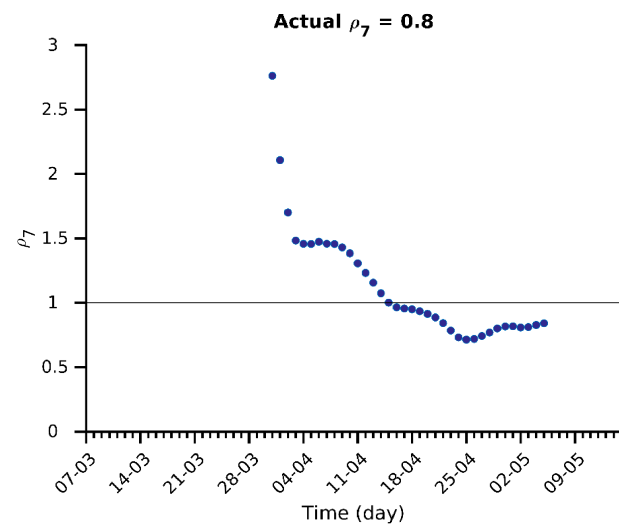
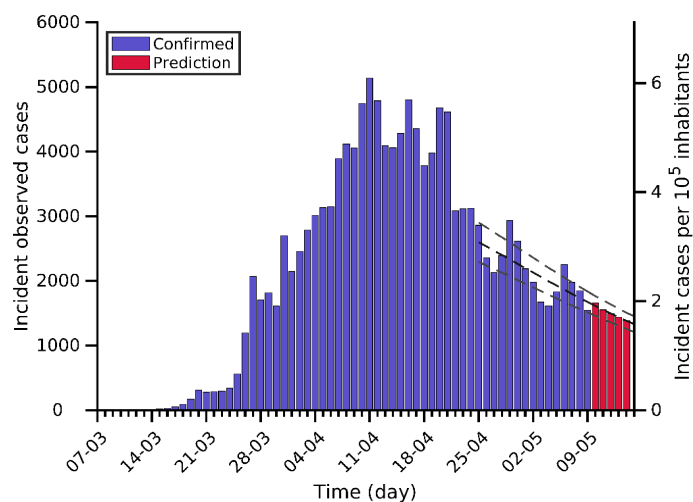
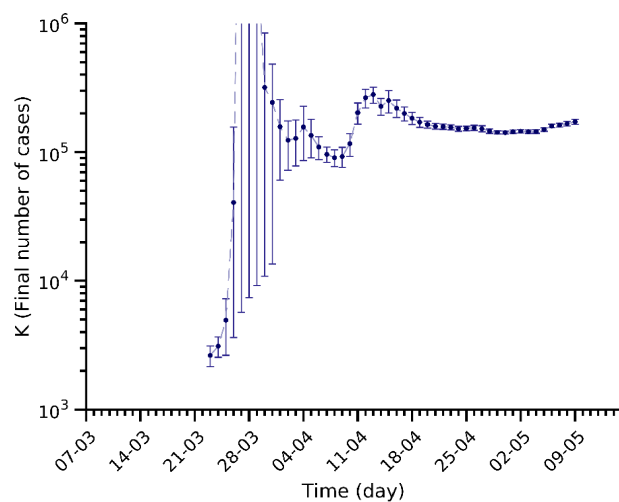
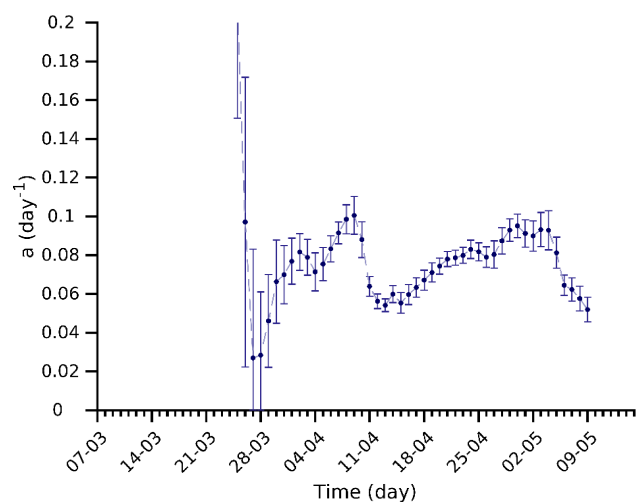
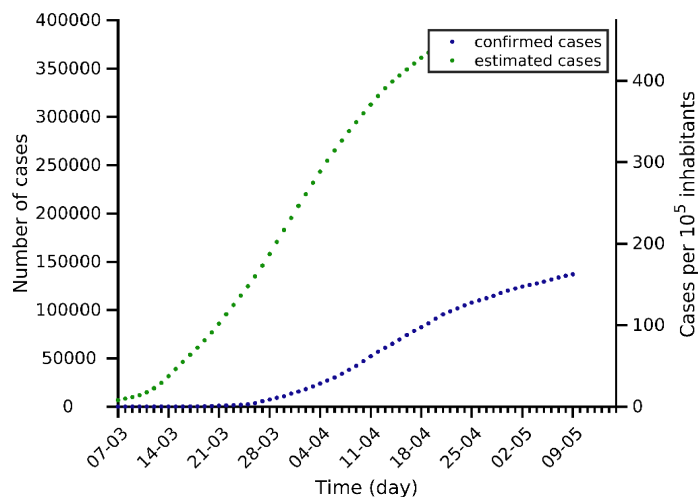
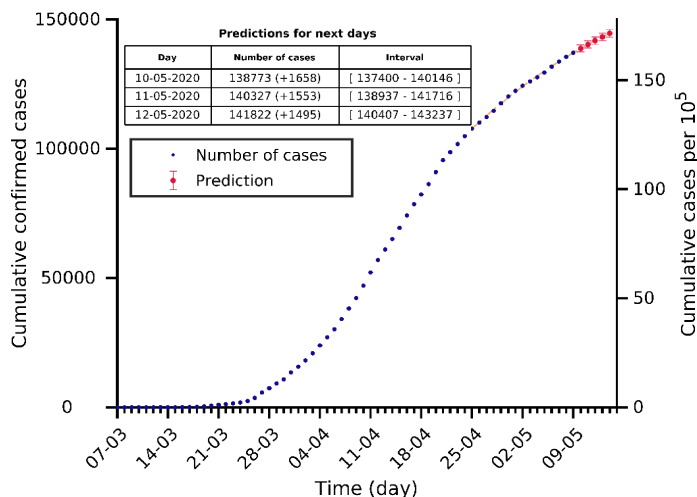
Russia 09-05-2020. Population: 145.9M. Current cumulated incidence: 136/10⁵



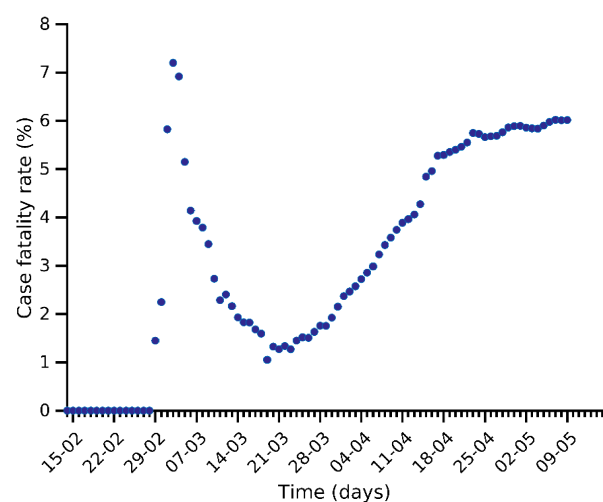
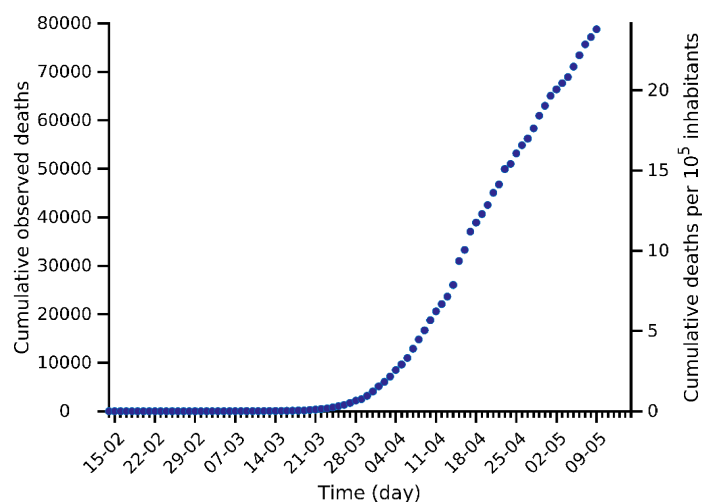
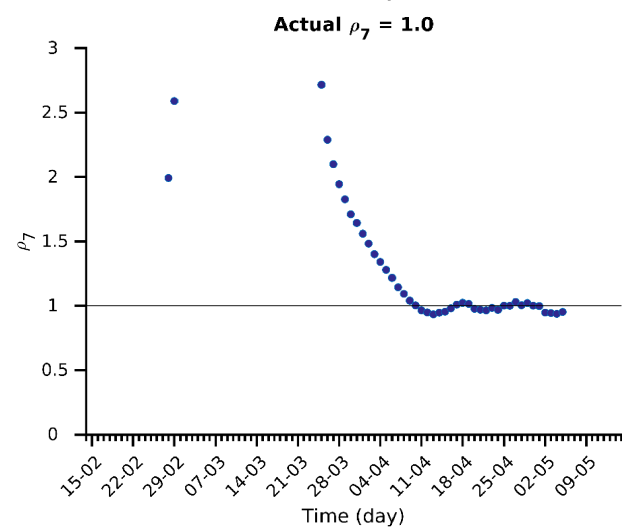
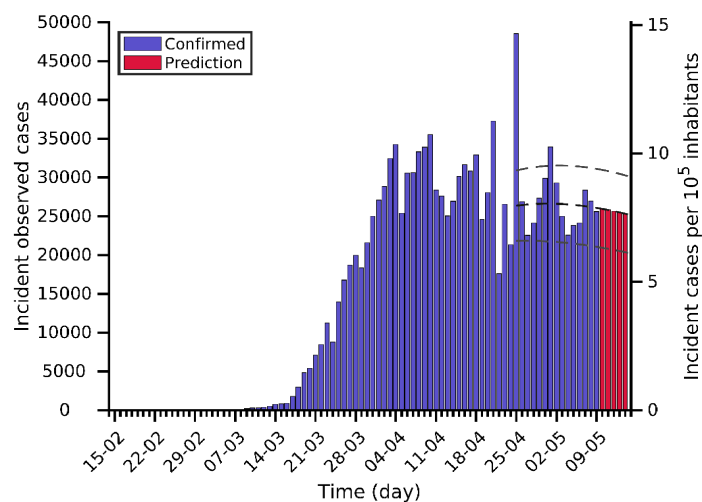
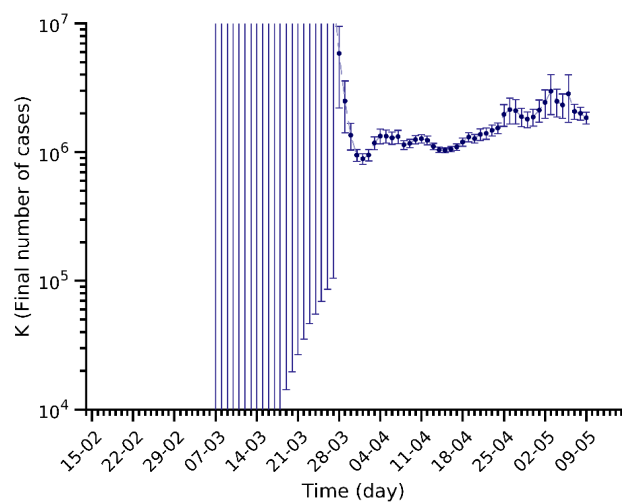
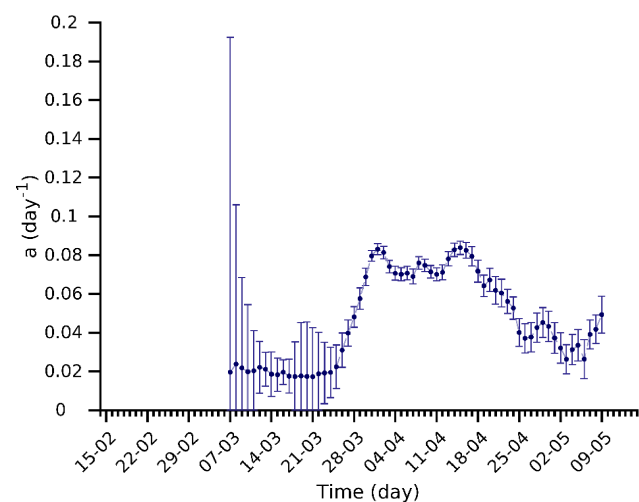
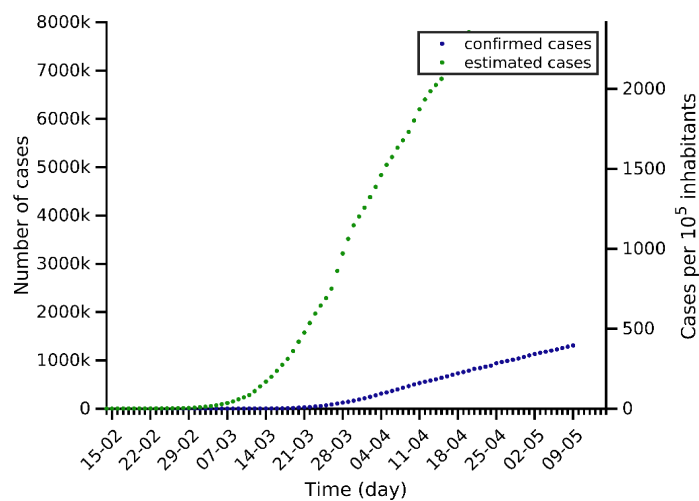
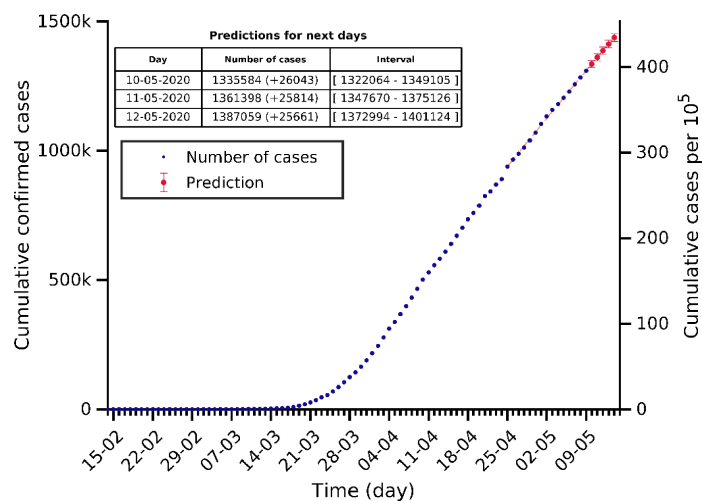
Brazil 09-05-2020. Population: 212.6M. Current cumulated incidence: 73/10⁵



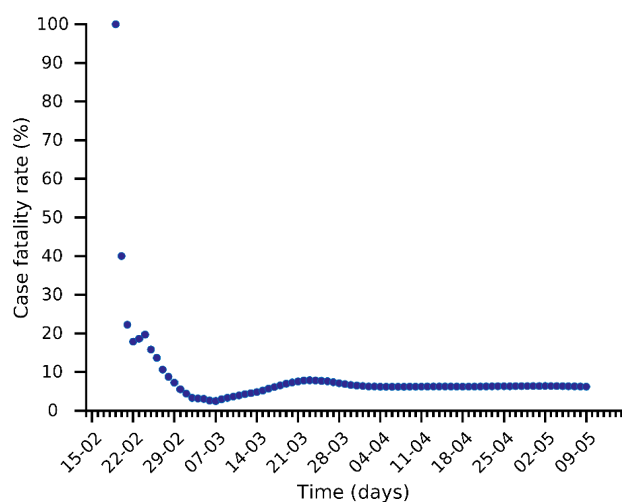
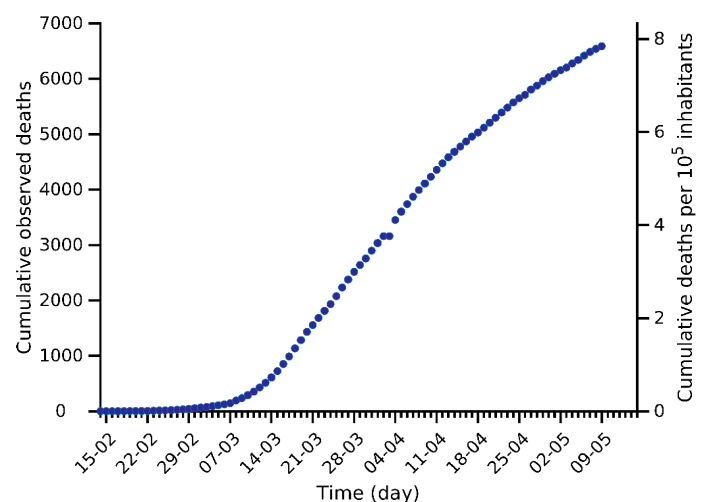
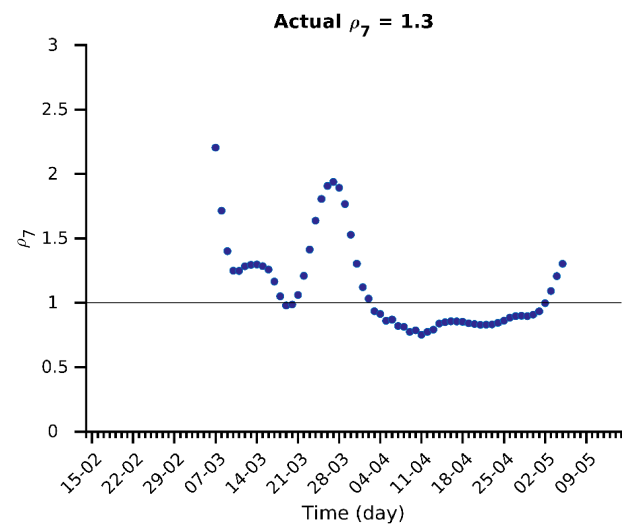
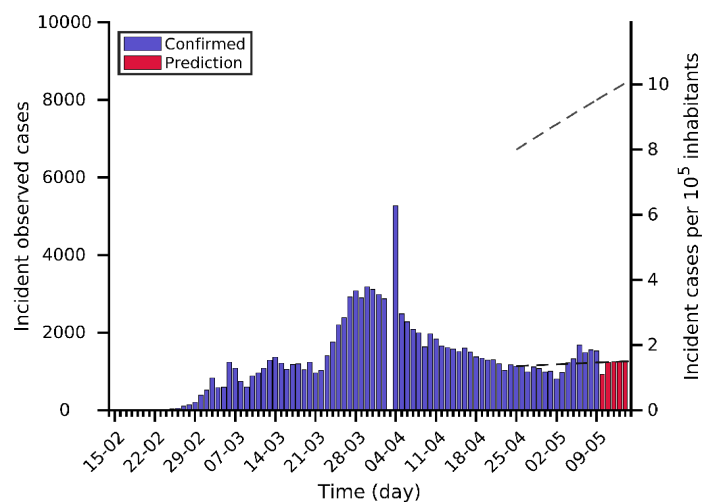
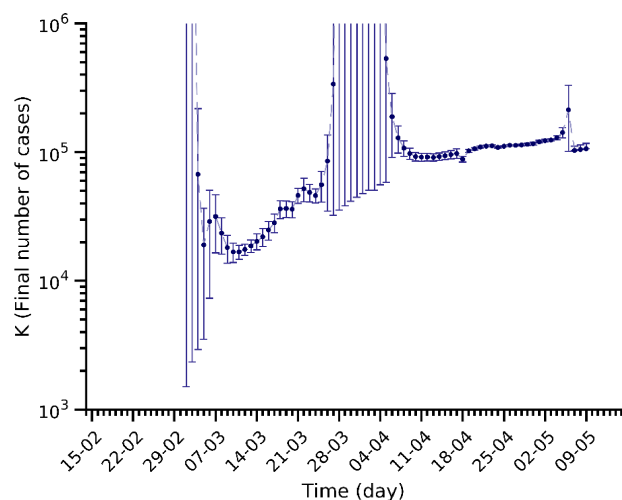
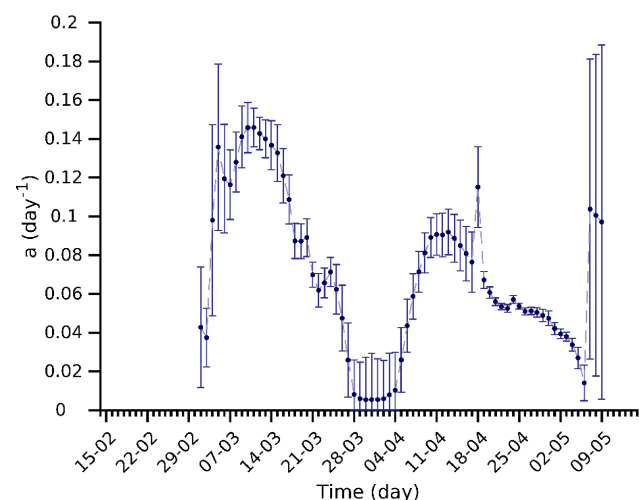
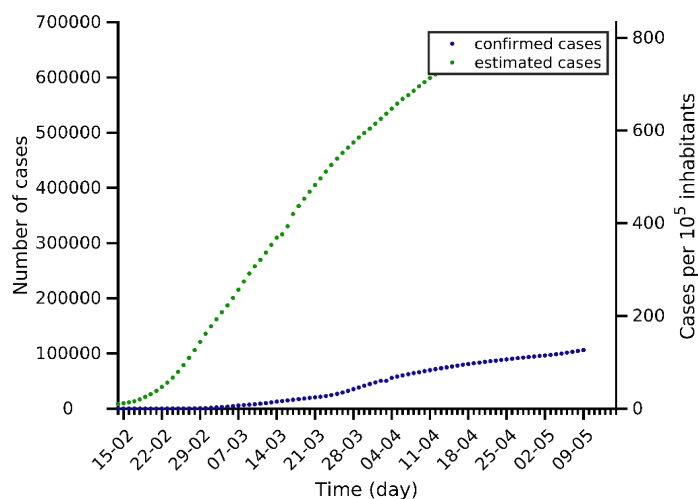
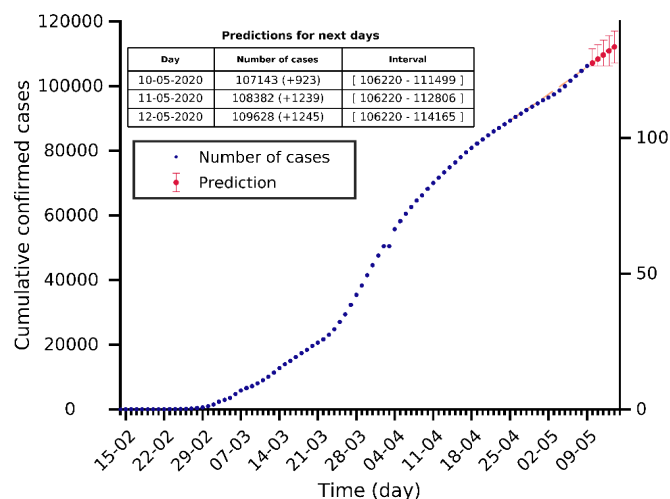
Turkey 09-05-2020. Population: 84.3M. Current cumulated incidence: 163/10⁵



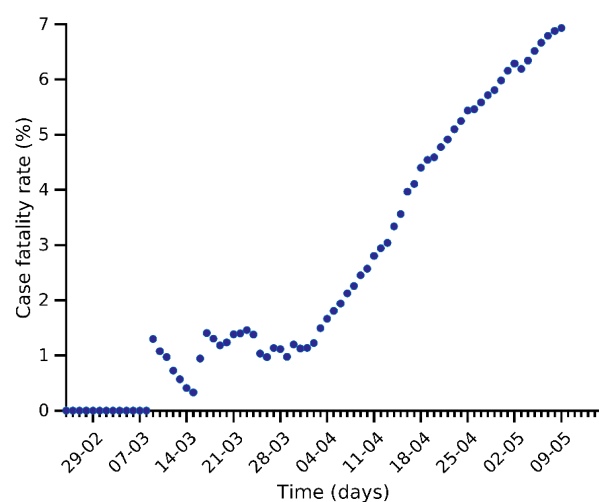
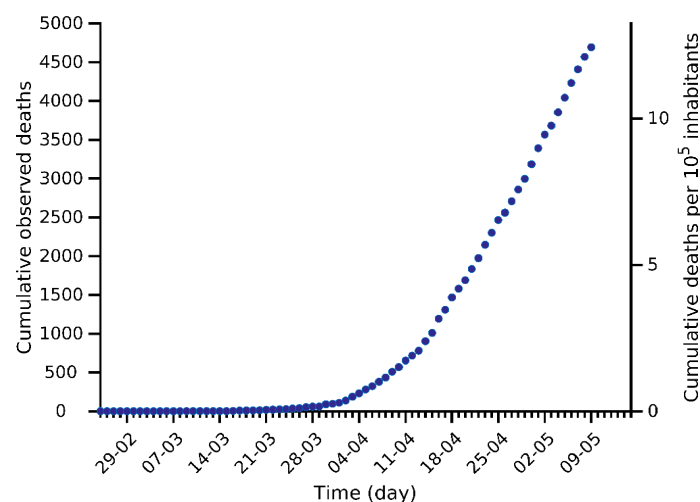
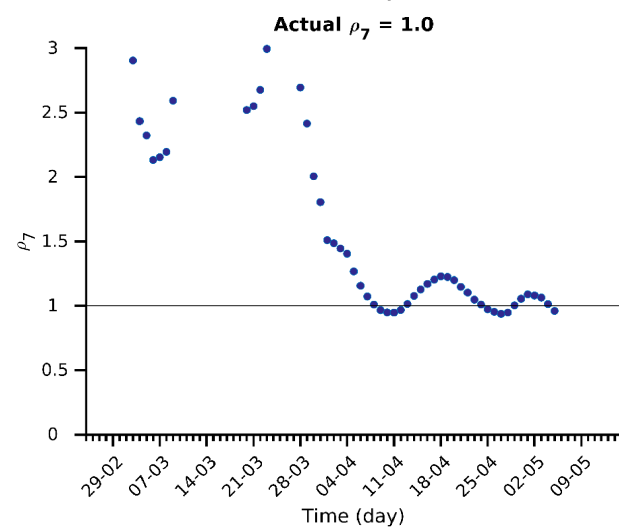
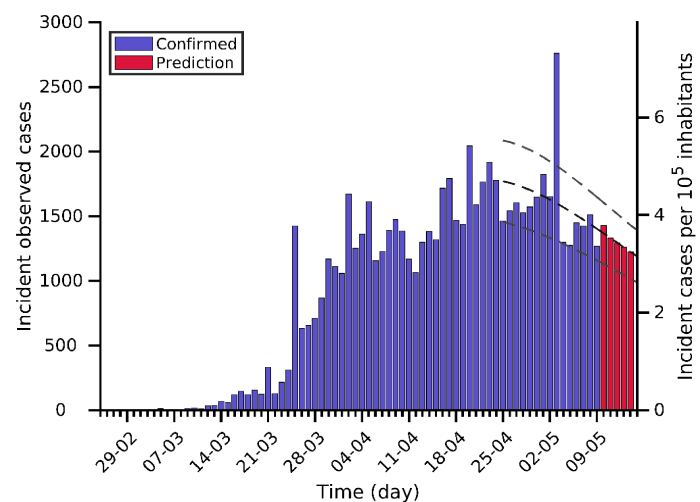
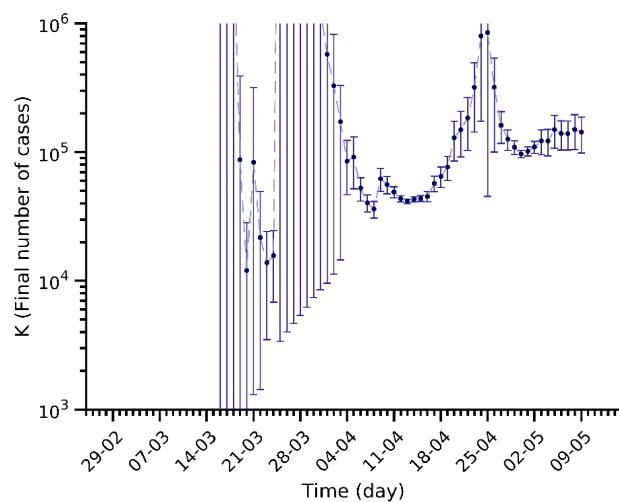
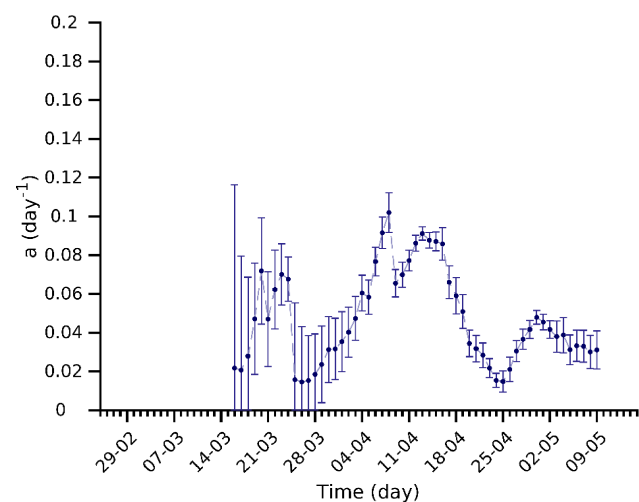
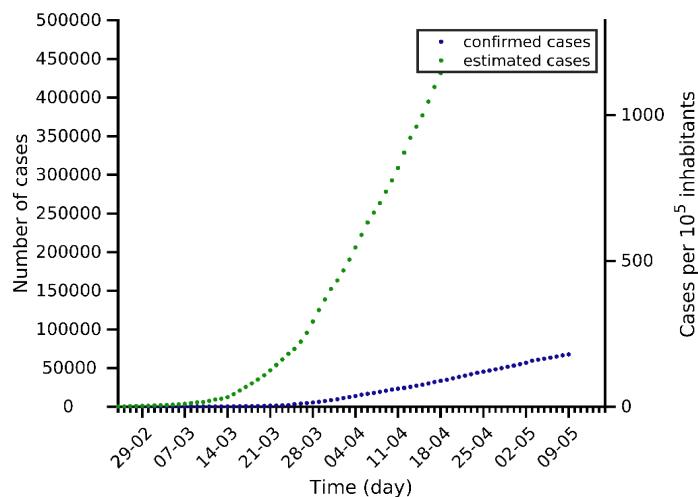
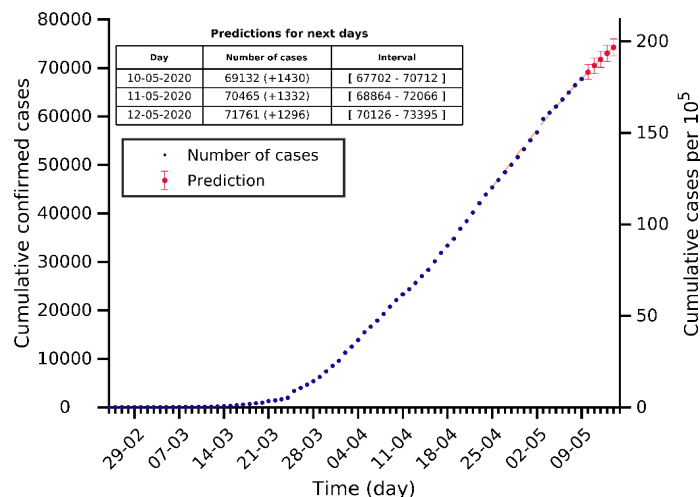
USA 09-05-2020. Population: 331.0M. Current cumulated incidence: 396/10⁵



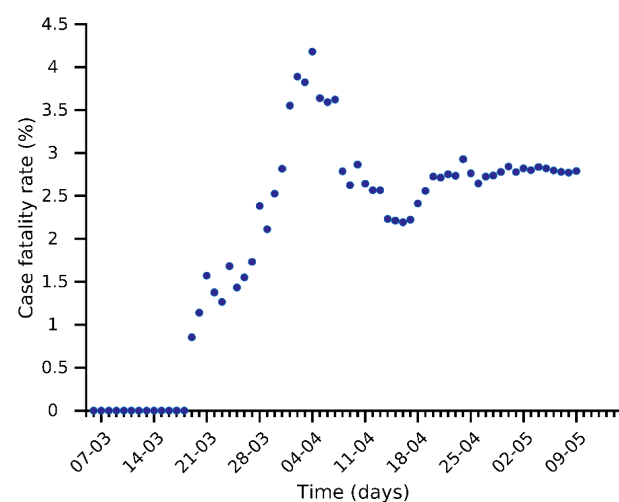
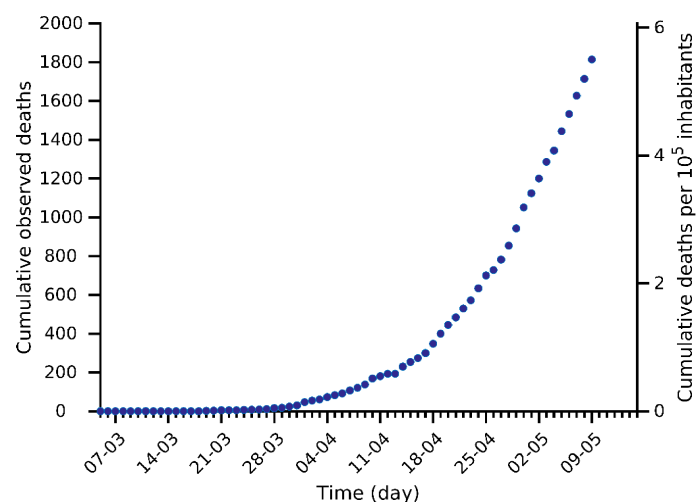
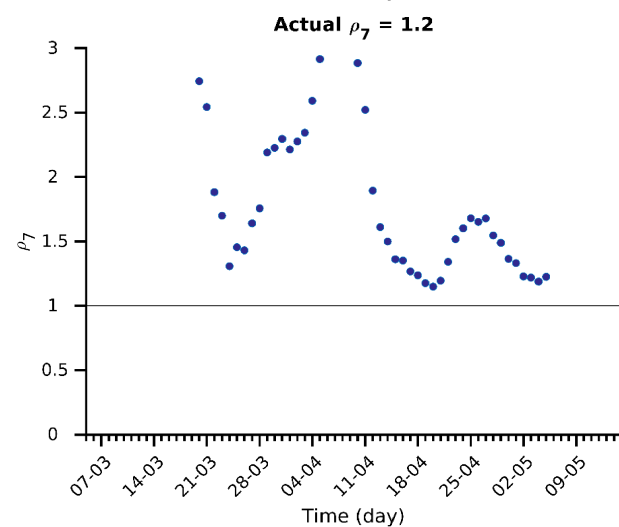
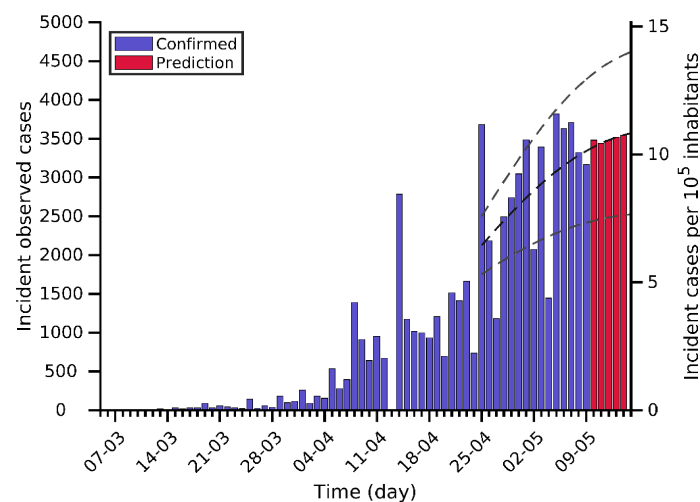
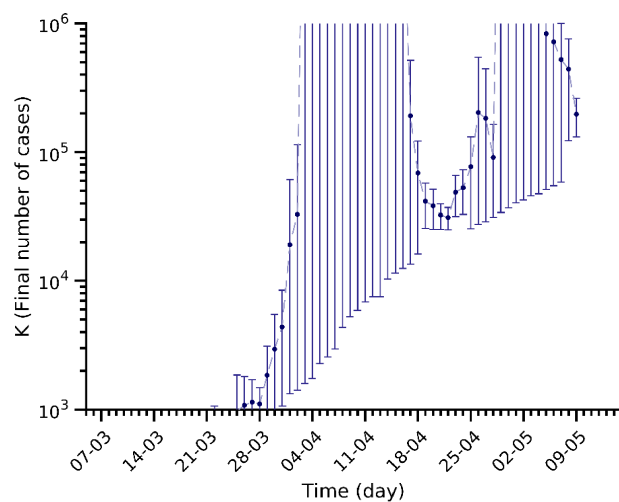
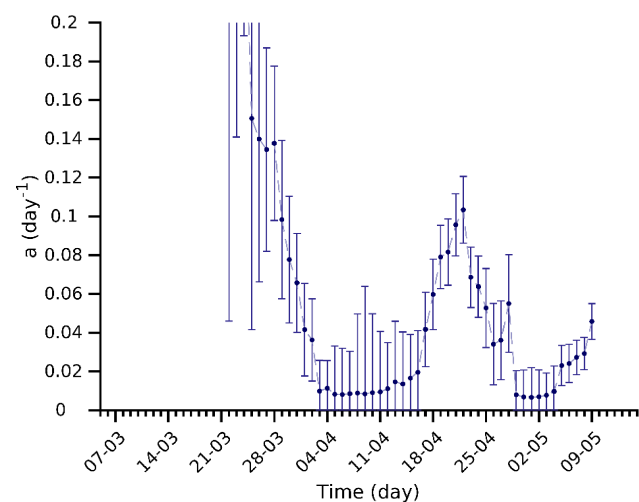
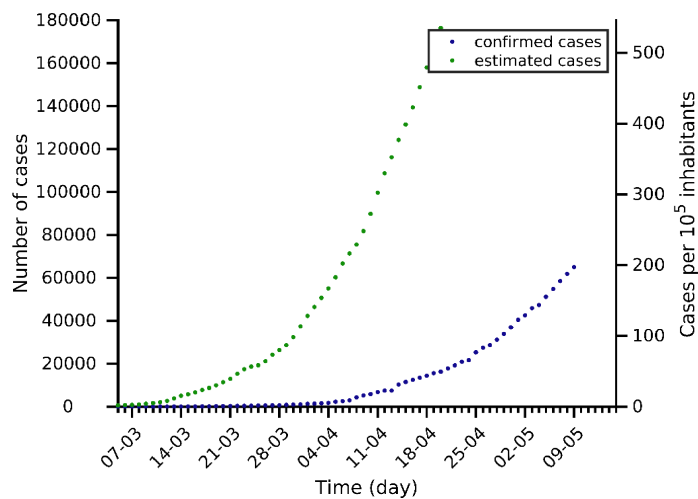
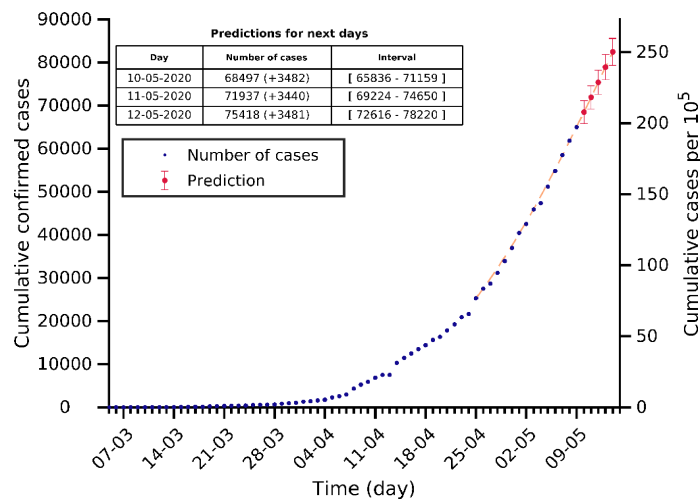
Iran 09-05-2020. Population: 84.0M. Current cumulated incidence: 126/10⁵



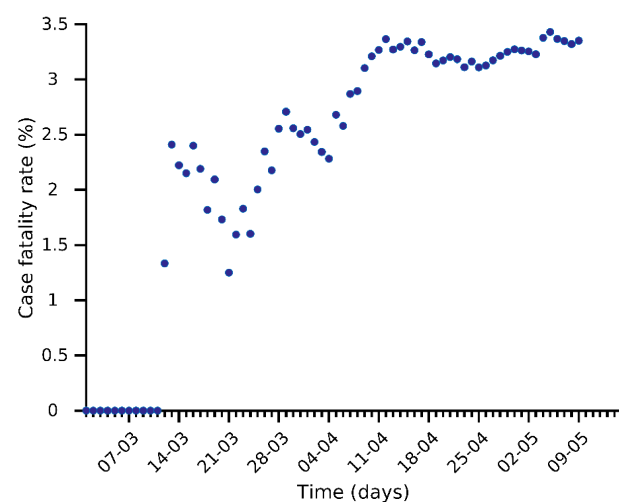
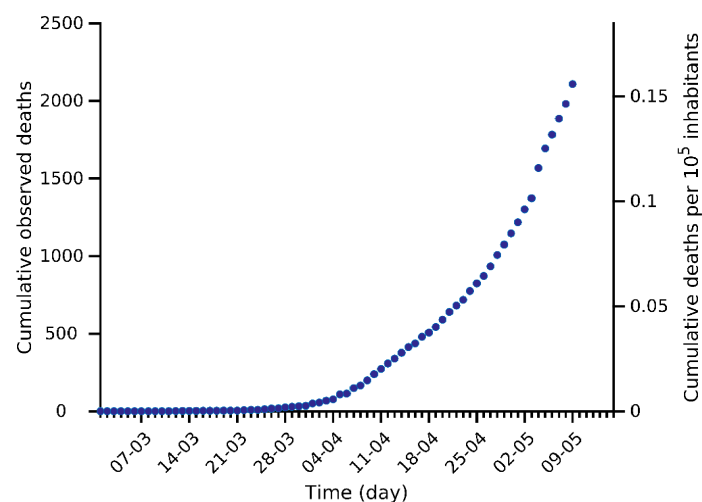
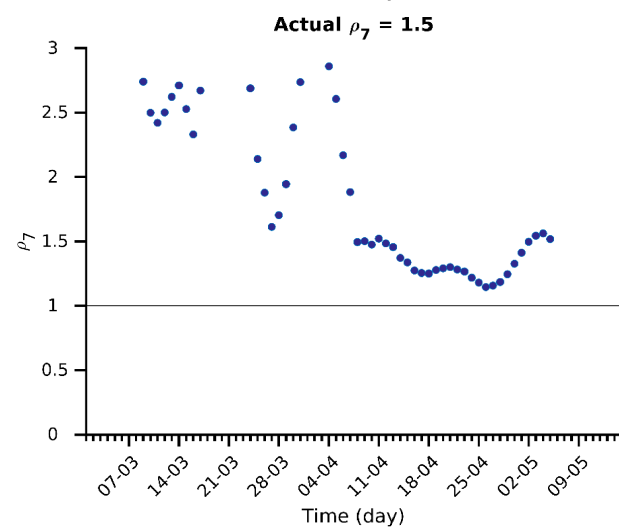
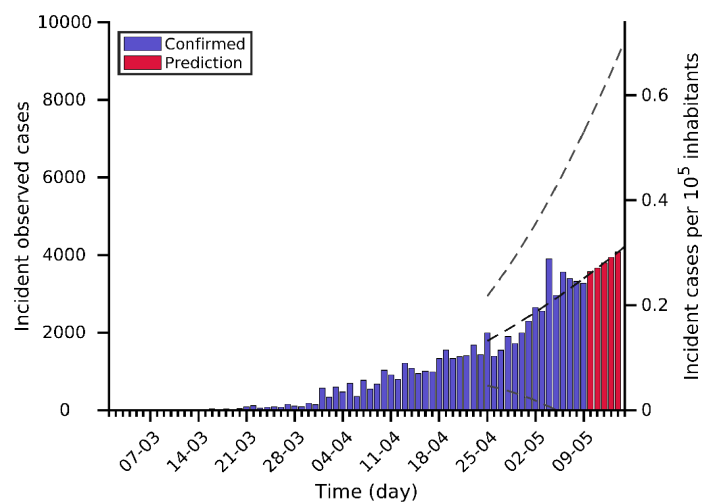
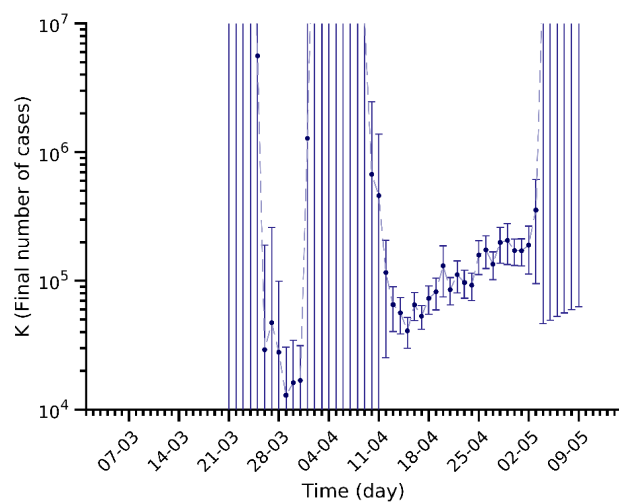
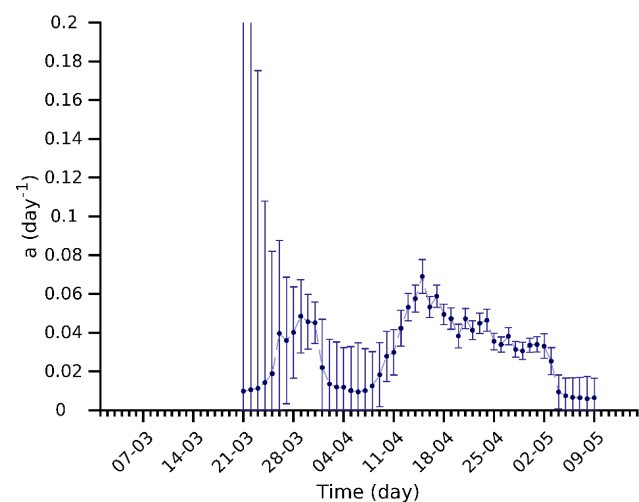
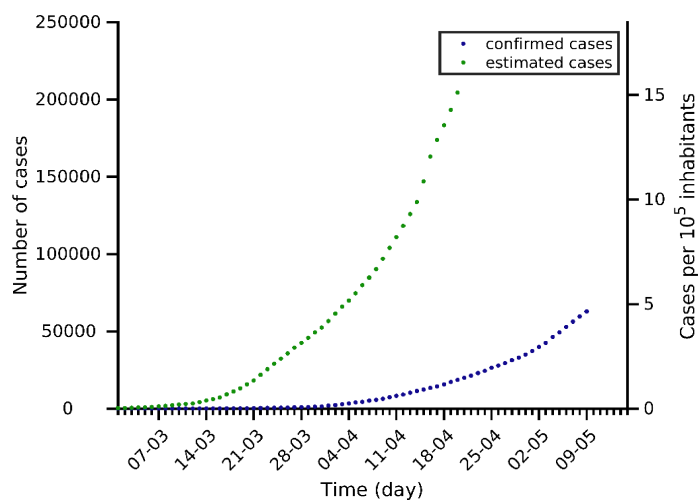
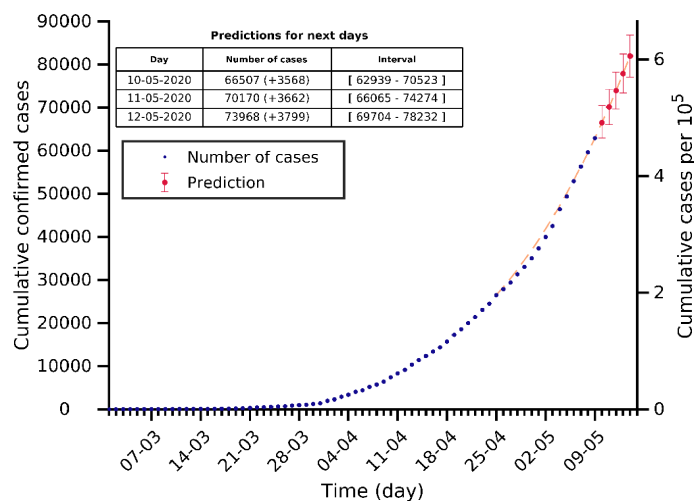
Canada 09-05-2020. Population: 37.7M. Current cumulated incidence: 179/10⁵



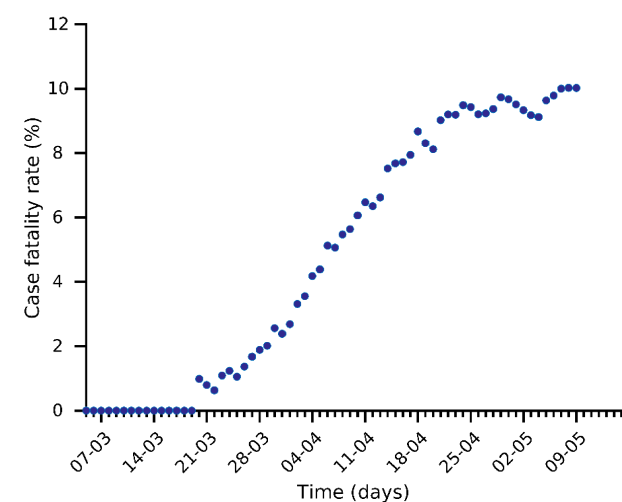
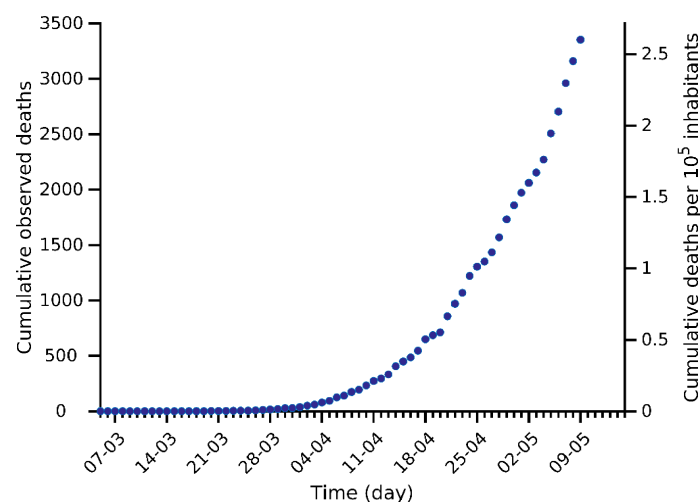
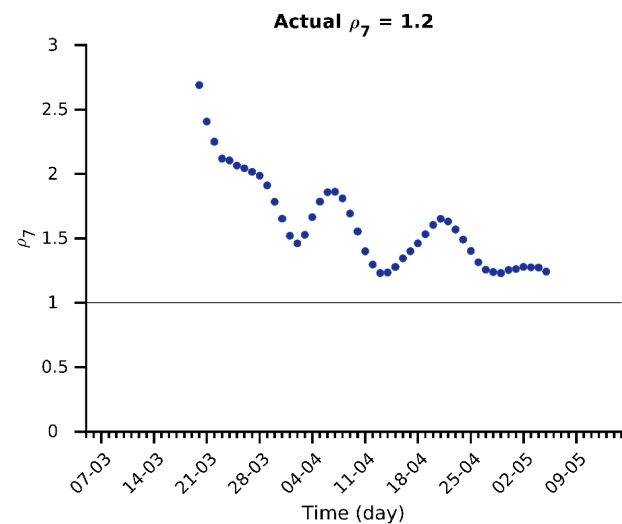
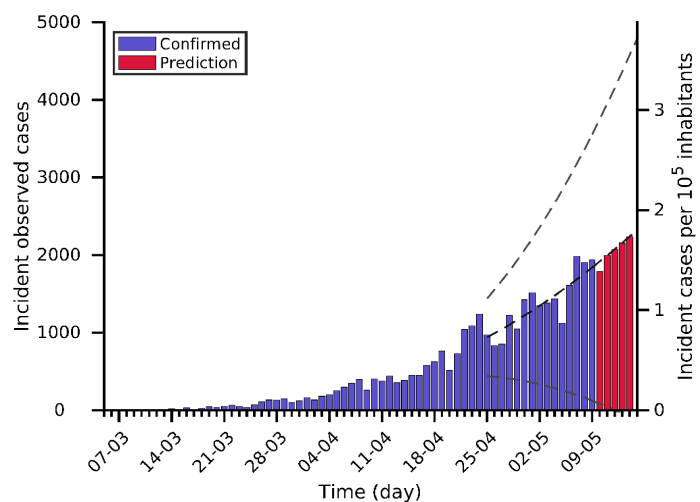
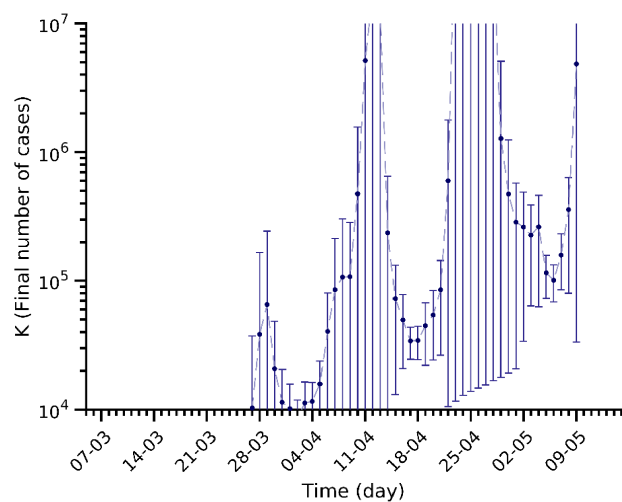
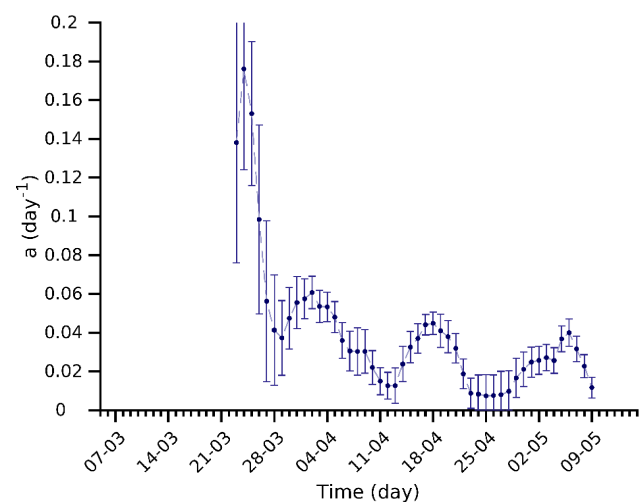
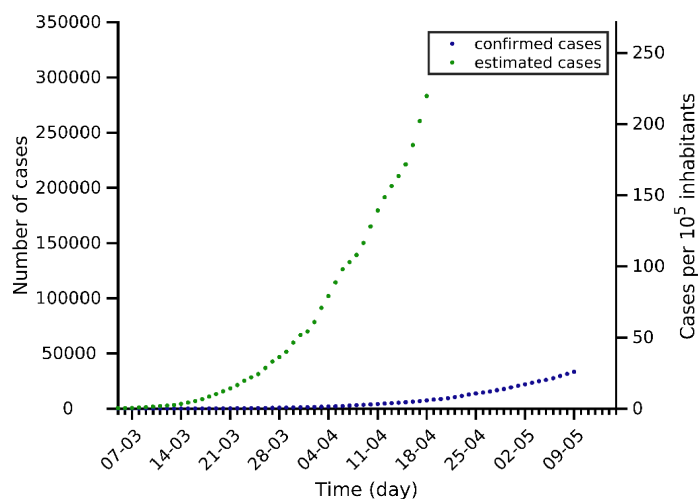
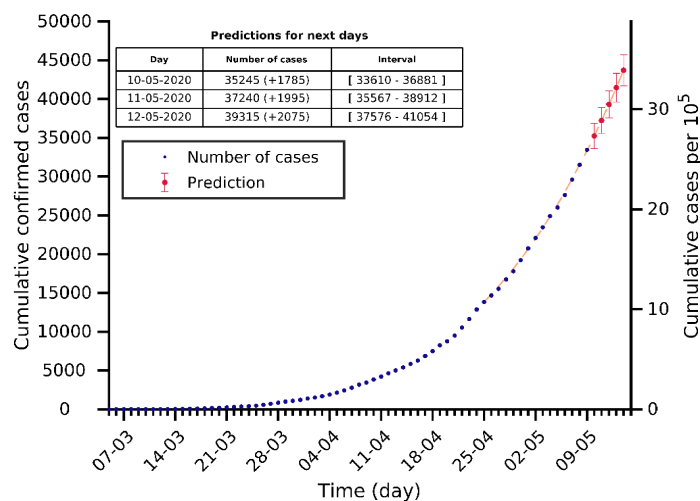
Peru 09-05-2020. Population: 33.0M. Current cumulated incidence: 197/10⁵



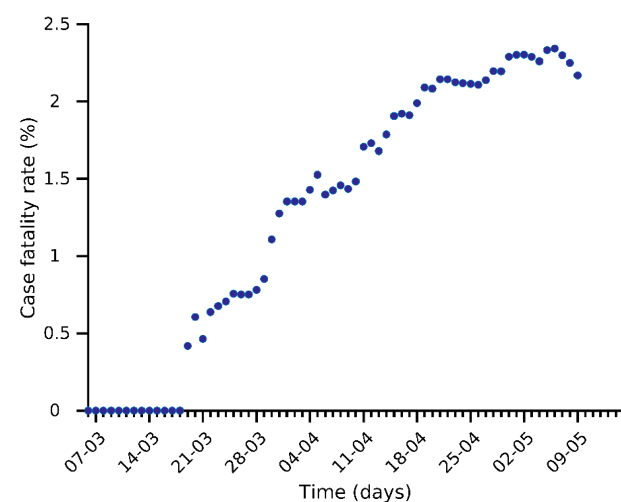
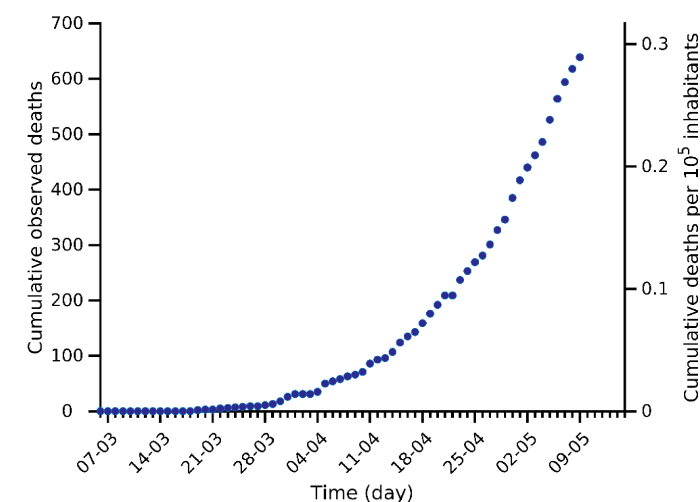
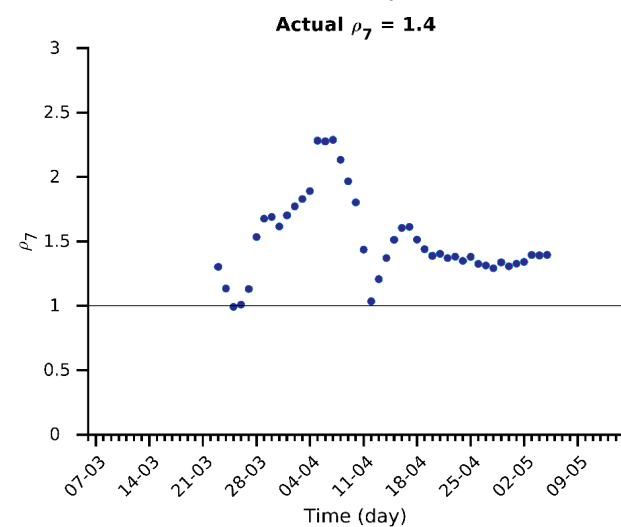
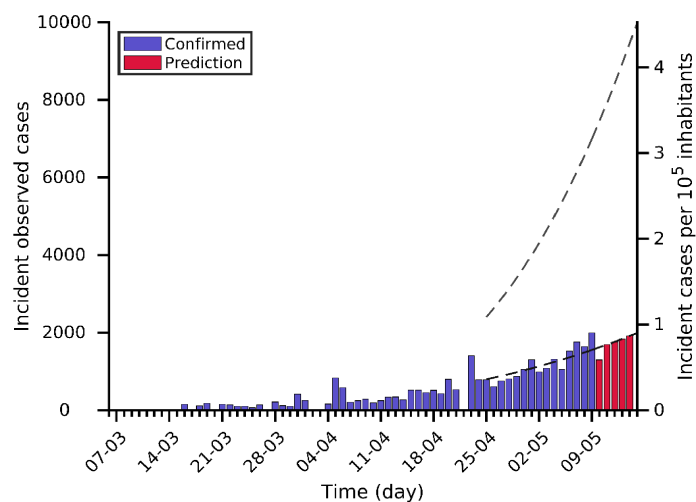
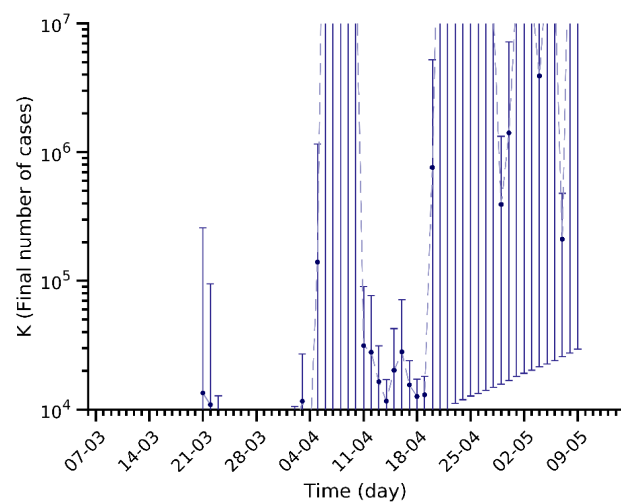
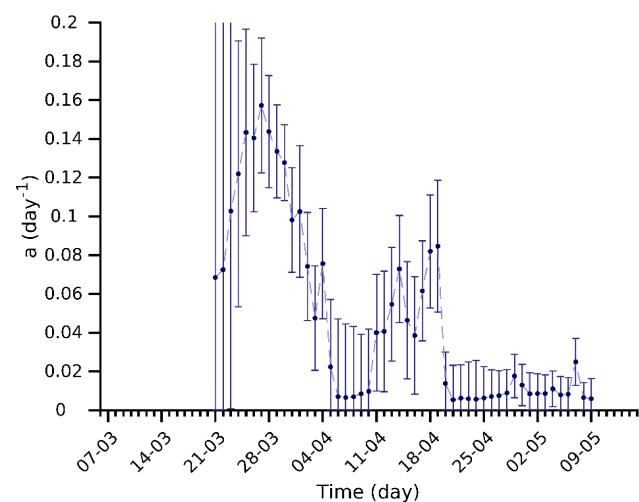
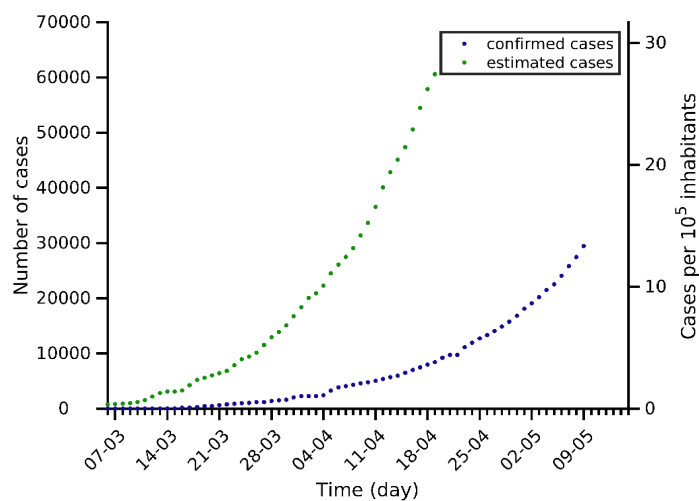
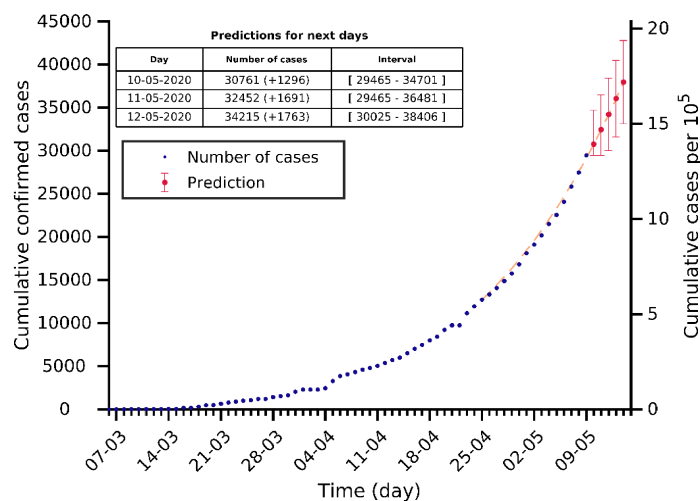
India 09-05-2020. Population: 1353.0M. Current cumulated incidence: 5/10⁵



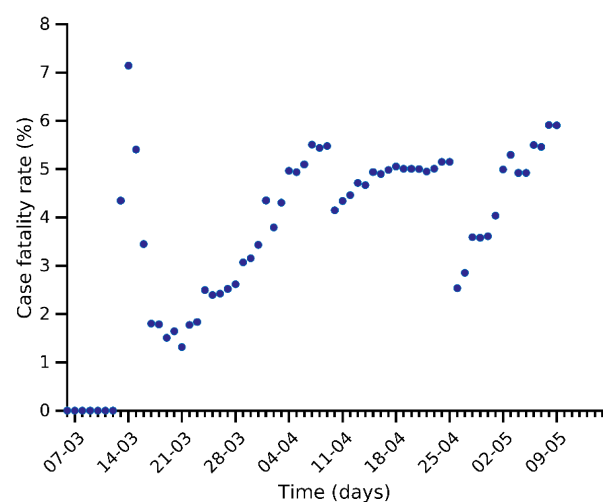
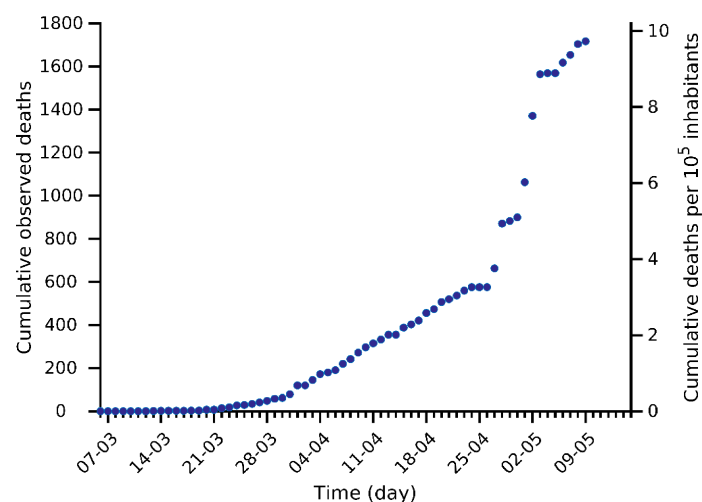
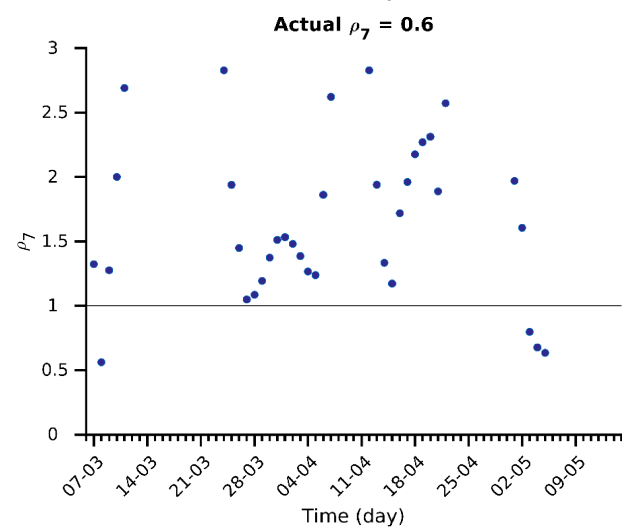
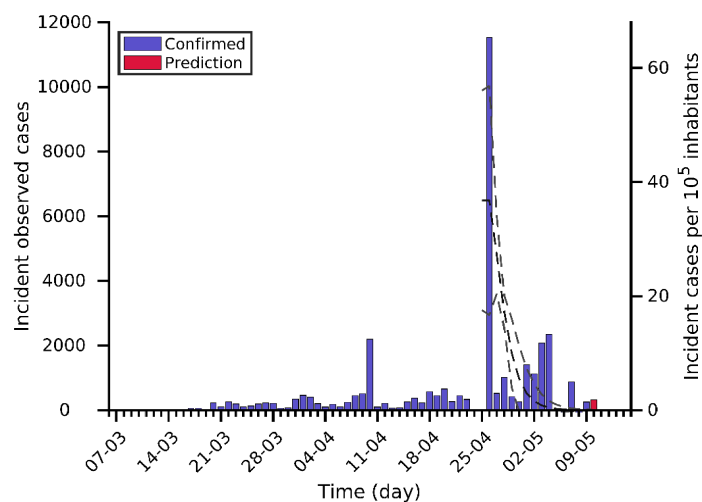
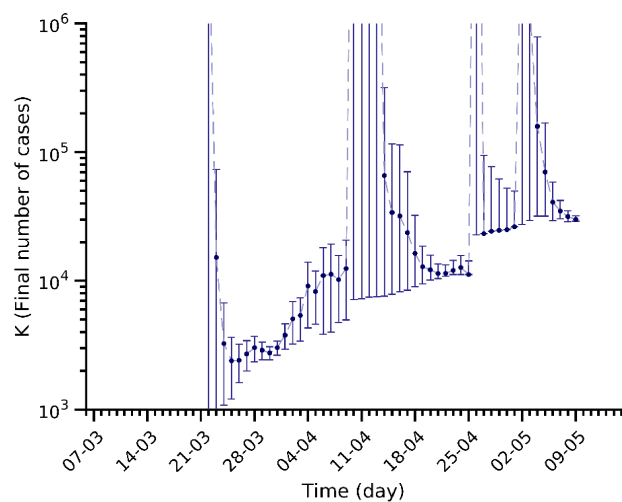
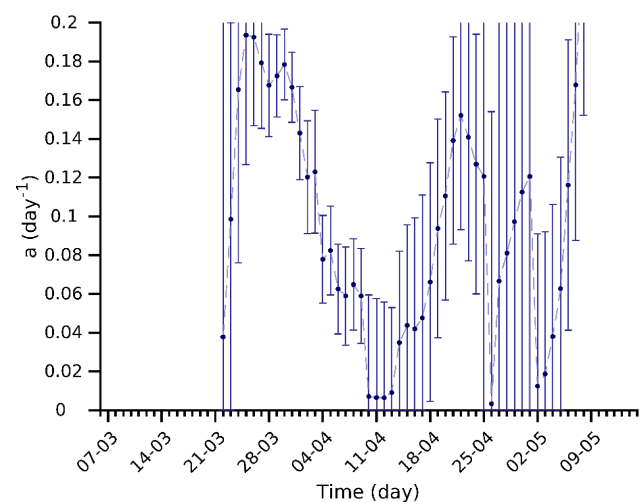
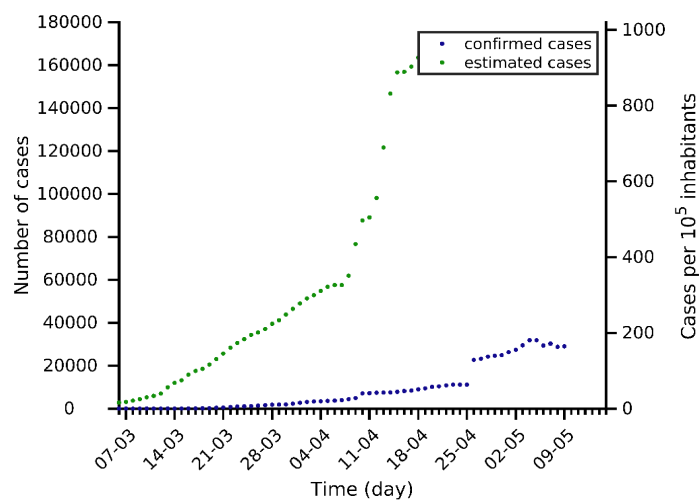
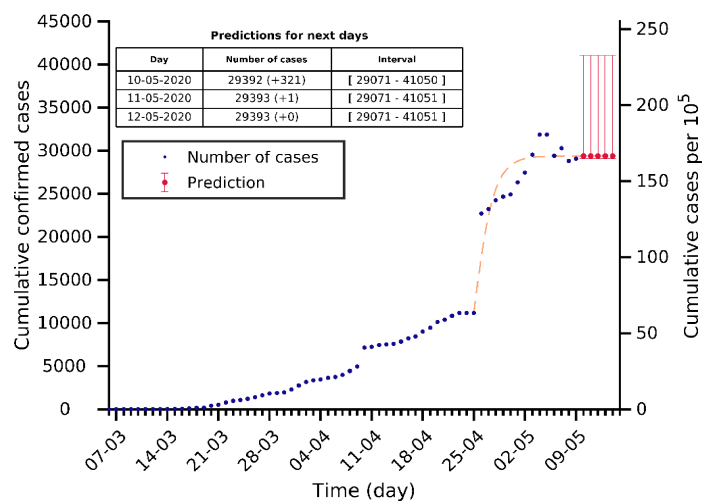
Mexico 09-05-2020. Population: 128.9M. Current cumulated incidence: 26/10⁵



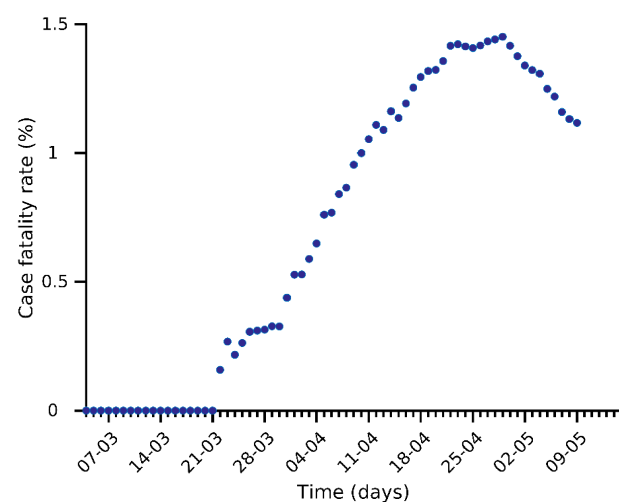
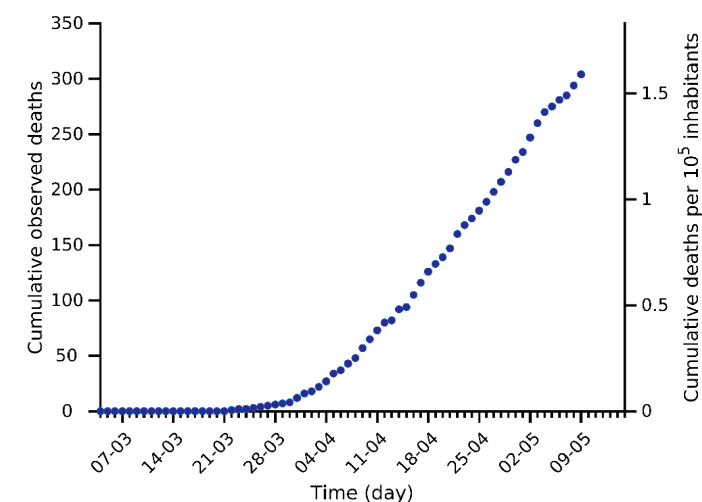
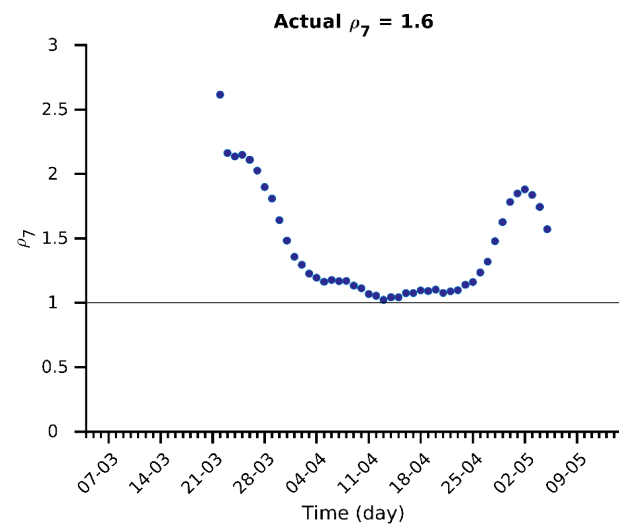
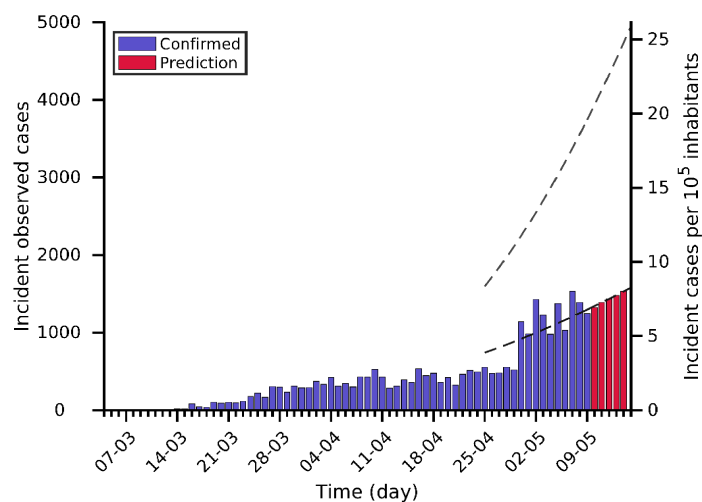
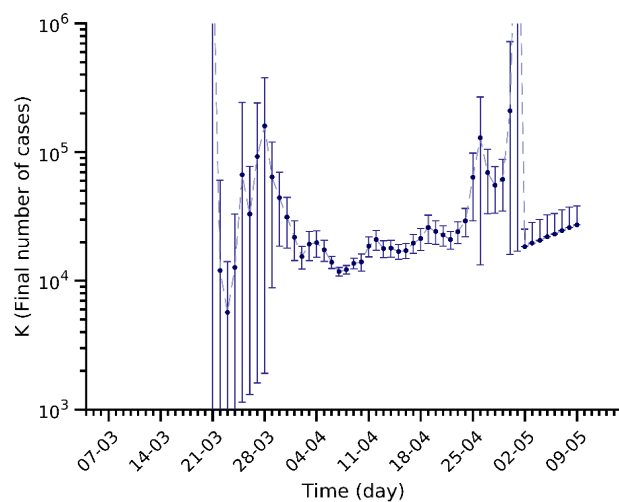
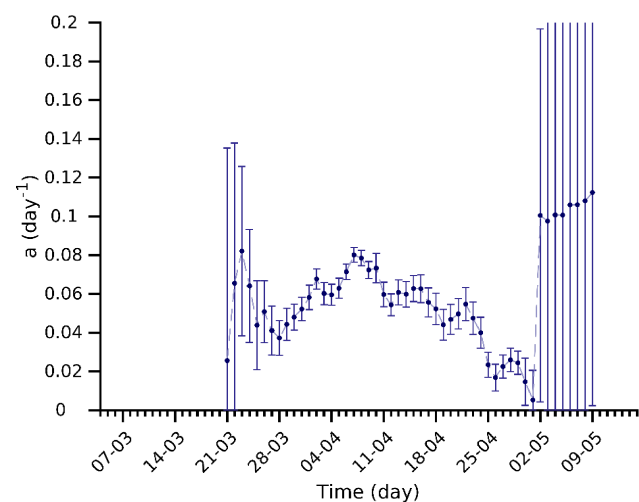
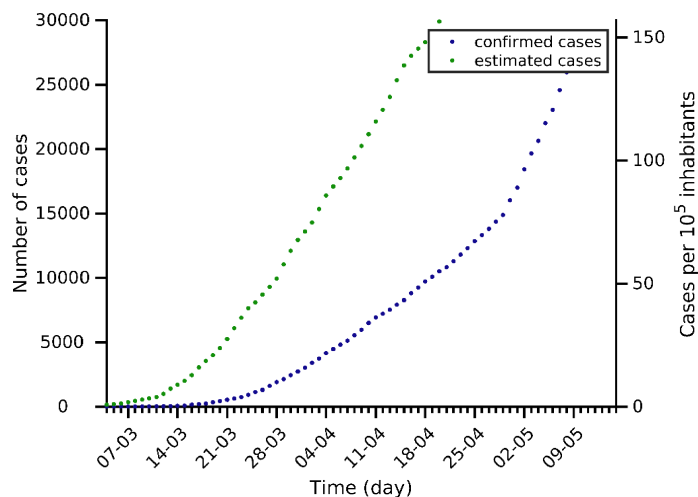
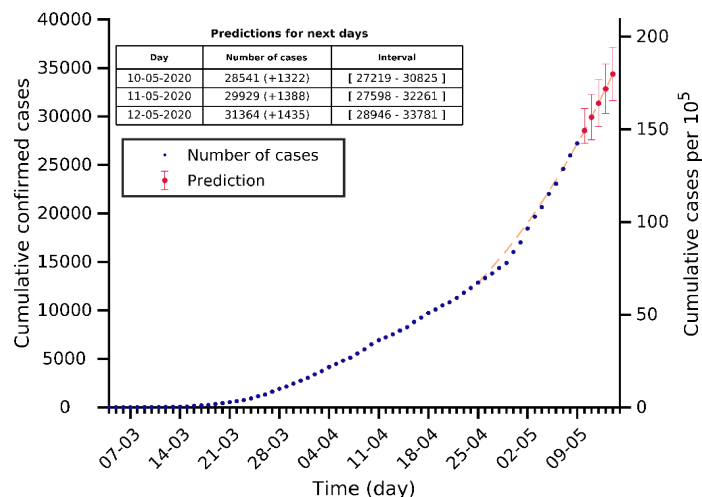
Pakistan 09-05-2020. Population: 220.9M. Current cumulated incidence: 13/10⁵



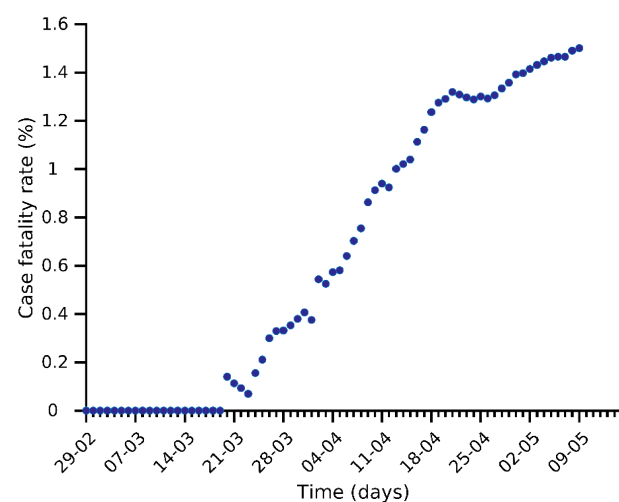
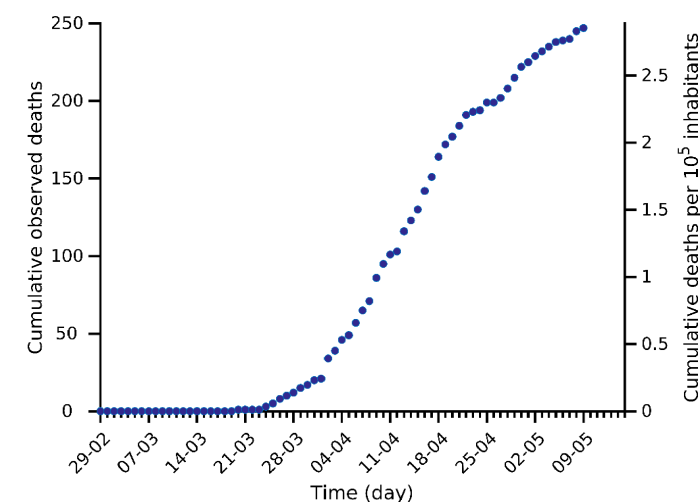
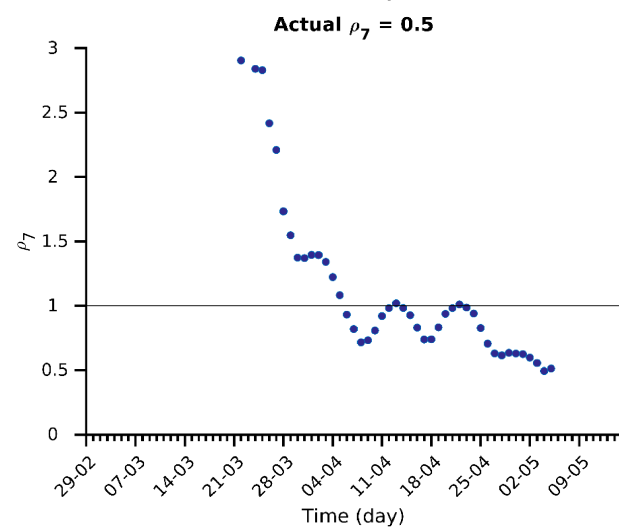
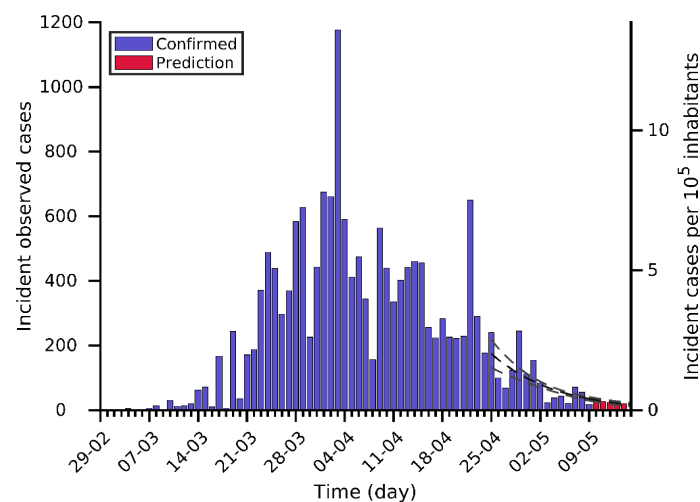
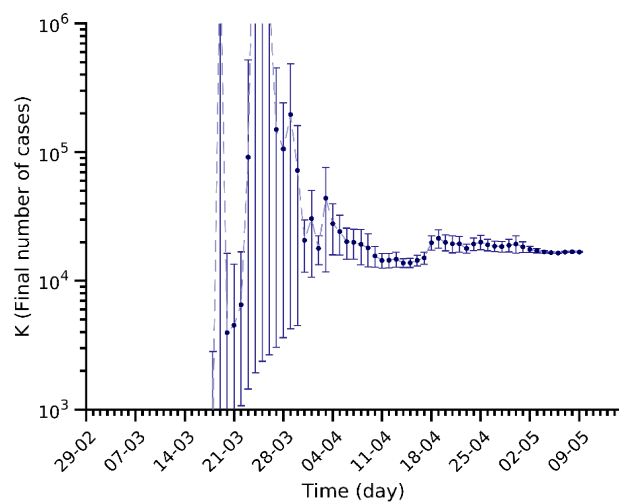
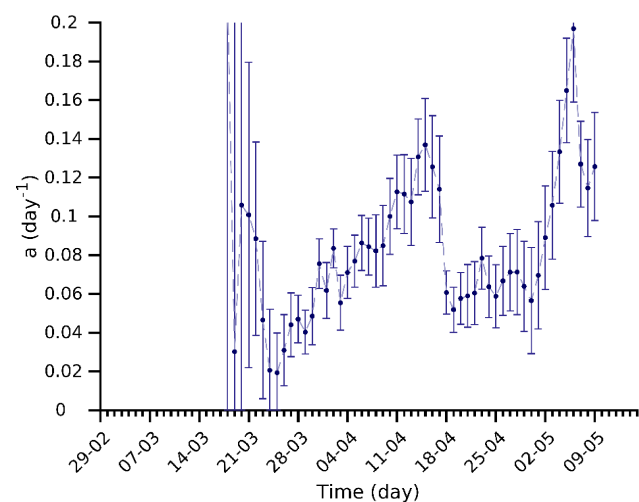
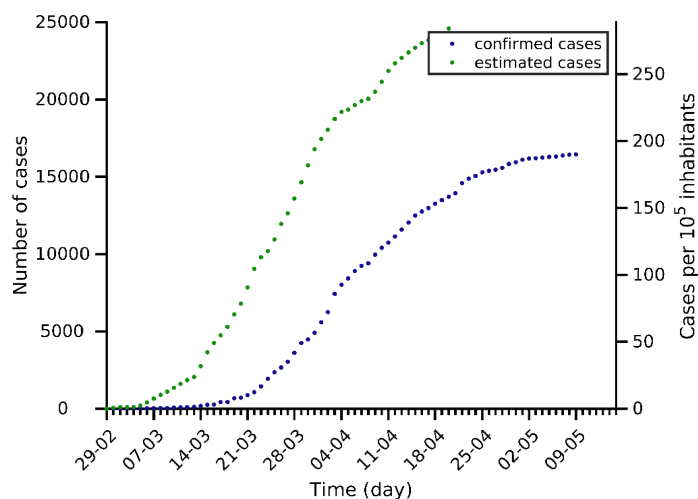
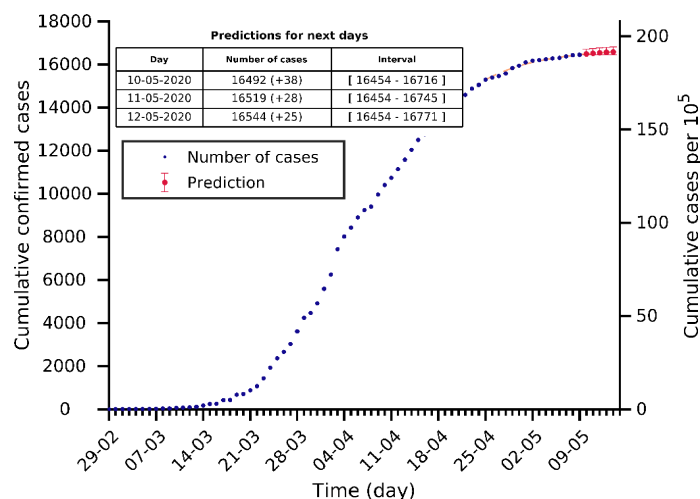
Ecuador 09-05-2020. Population: 17.6M. Current cumulated incidence: 165/10⁵



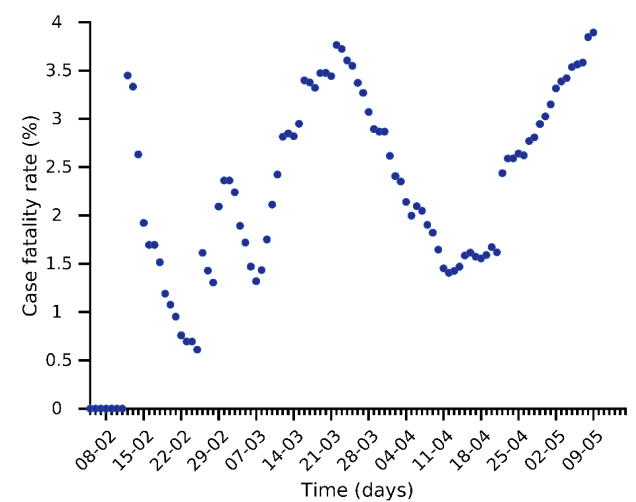
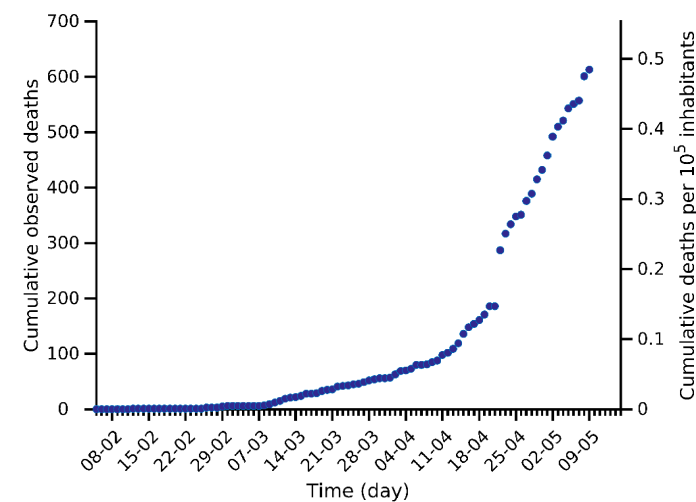
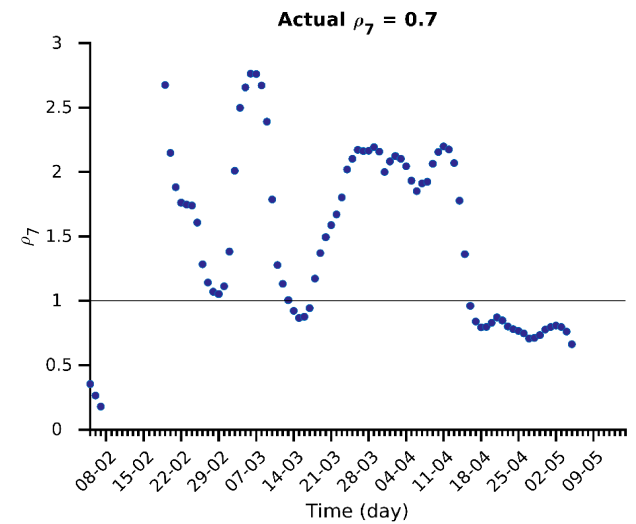
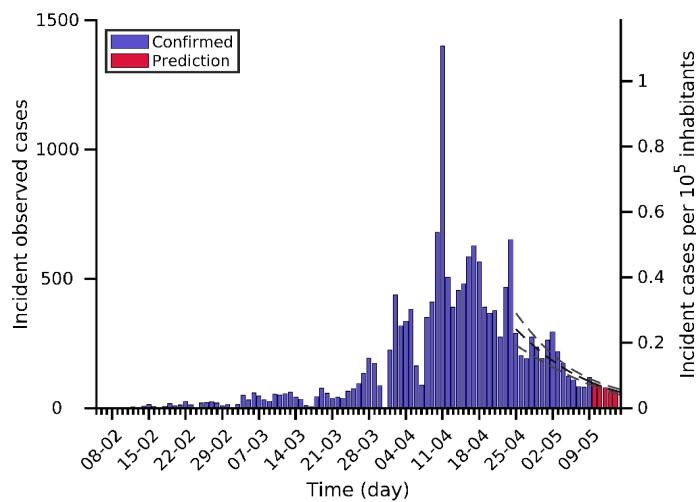
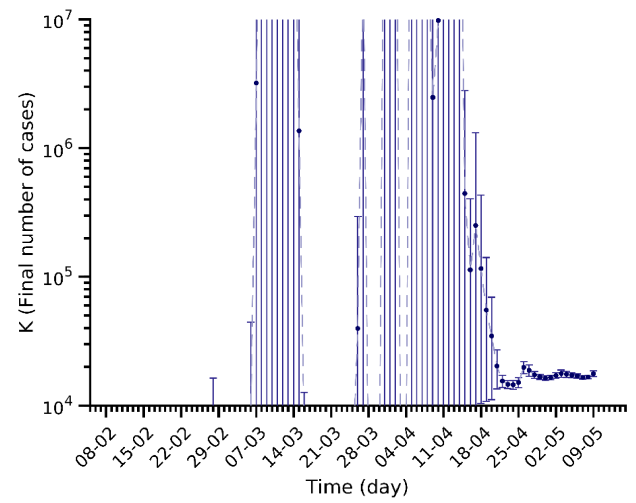
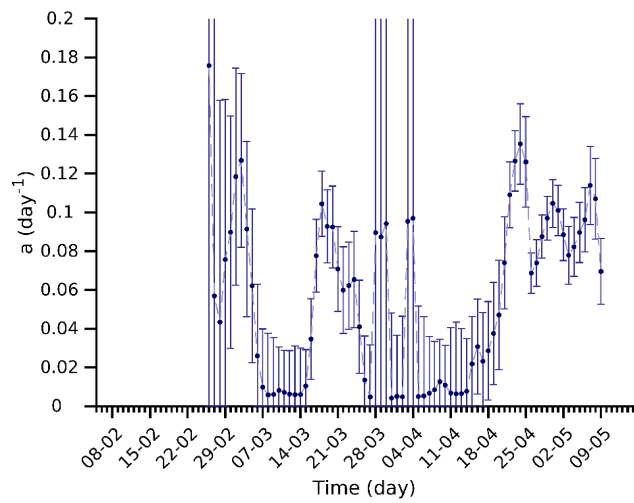
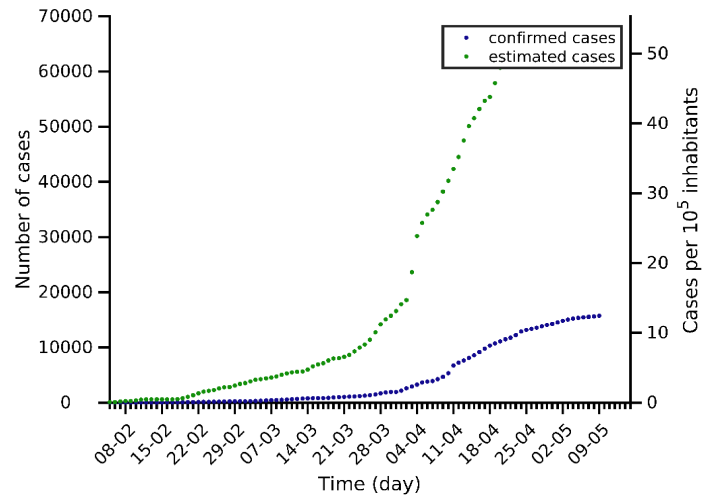
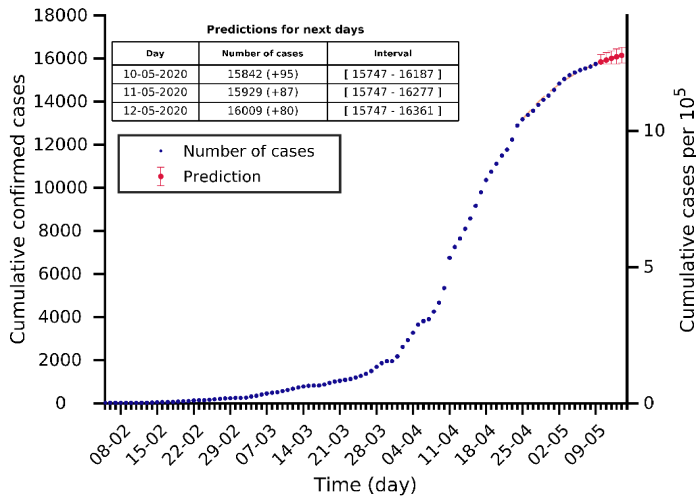
Chile 09-05-2020. Population: 19.1M. Current cumulated incidence: 142/10⁵



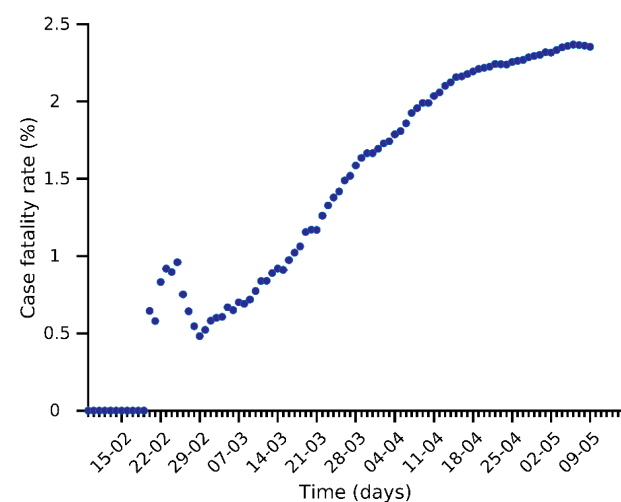
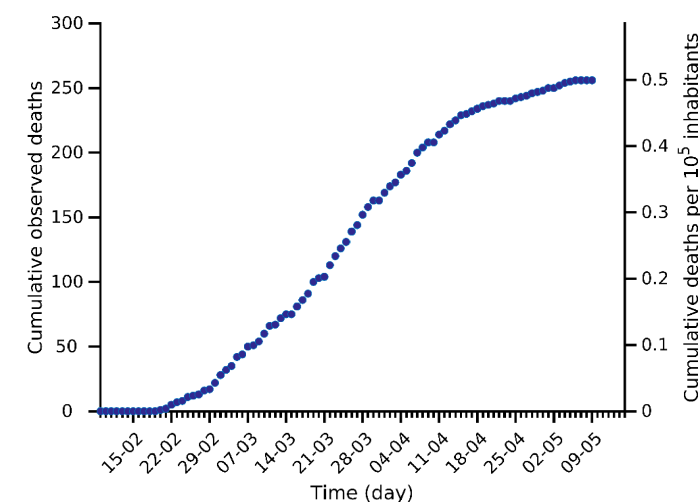
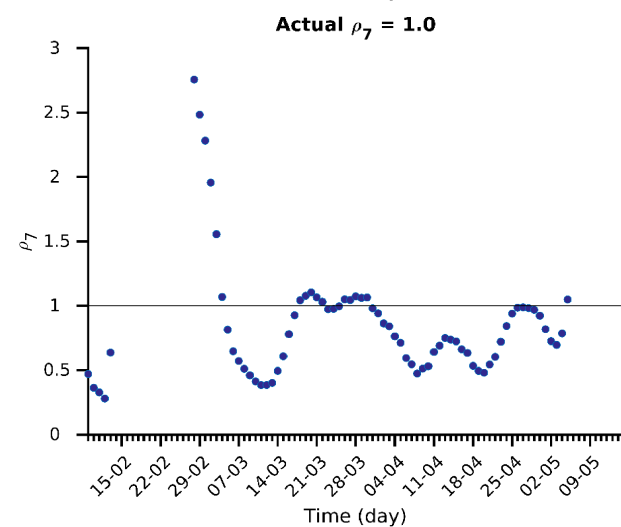
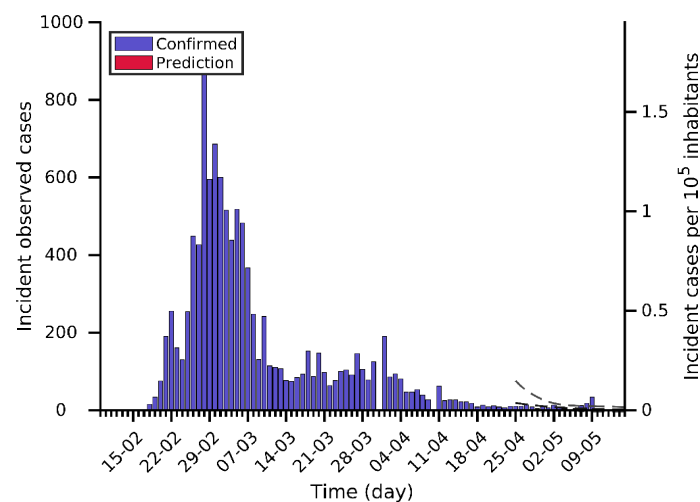
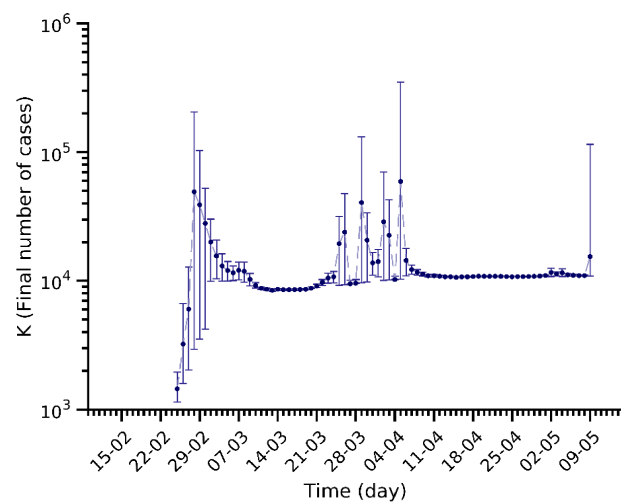
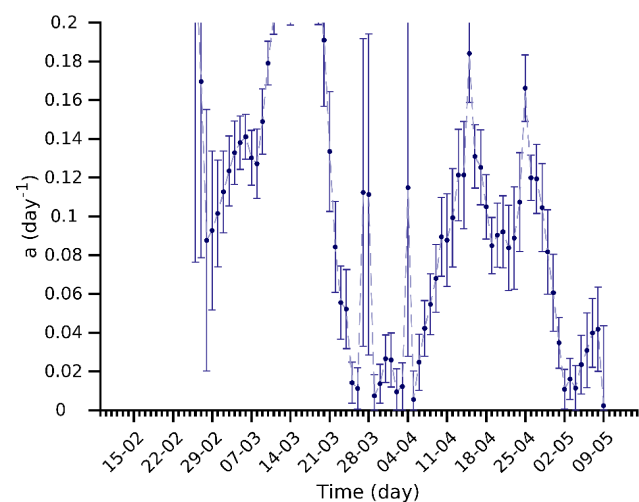
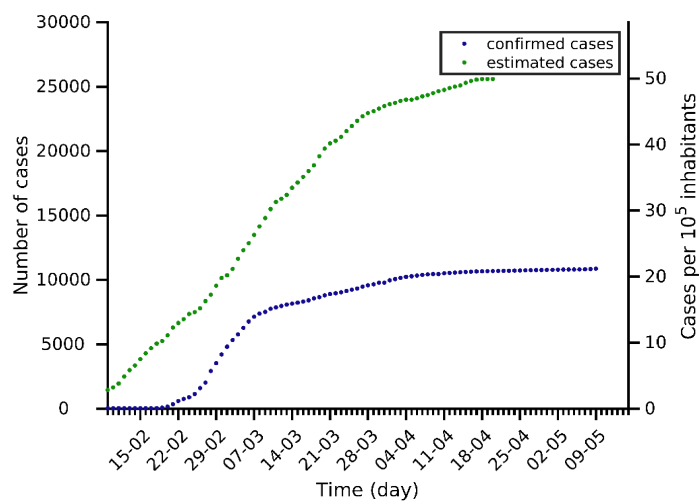
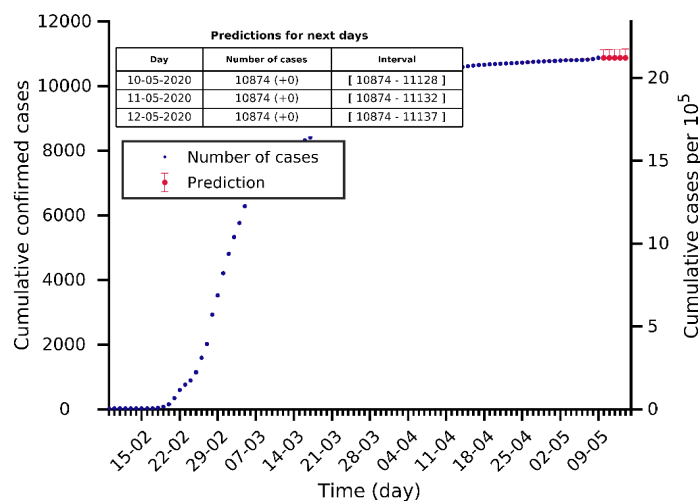
Israel 09-05-2020. Population: 8.7M. Current cumulated incidence: 190/10⁵



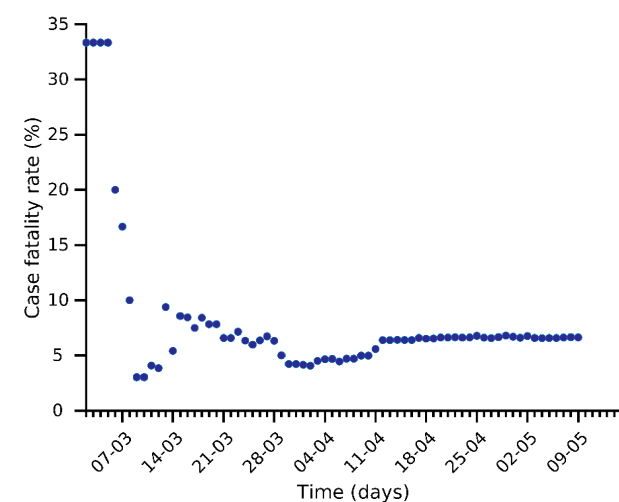
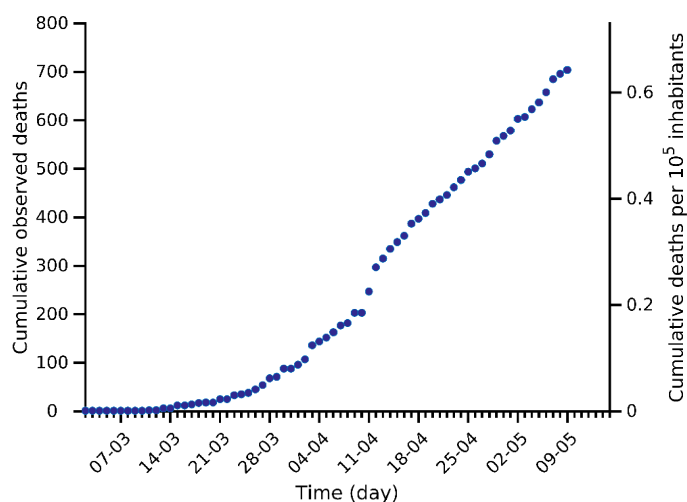
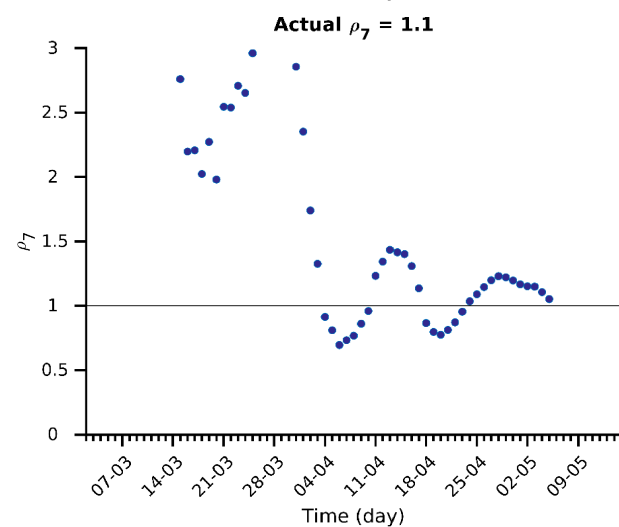
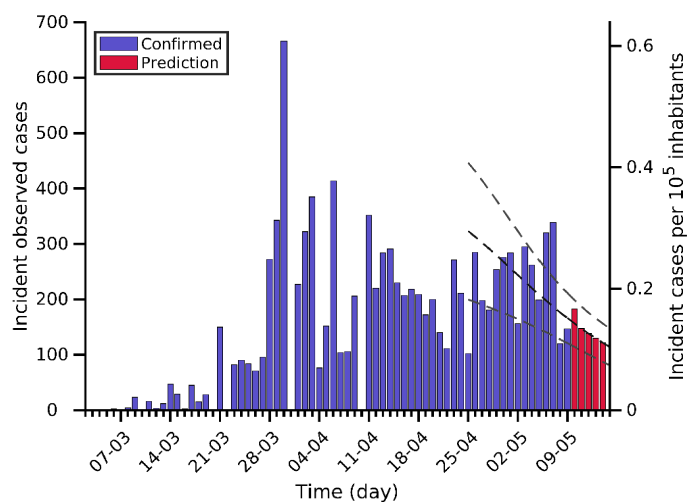
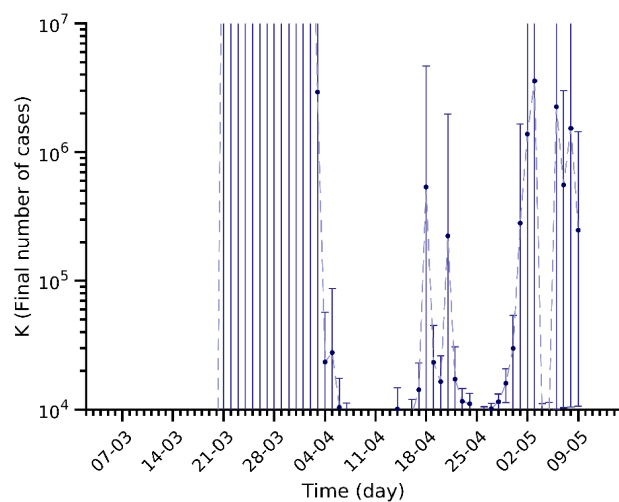
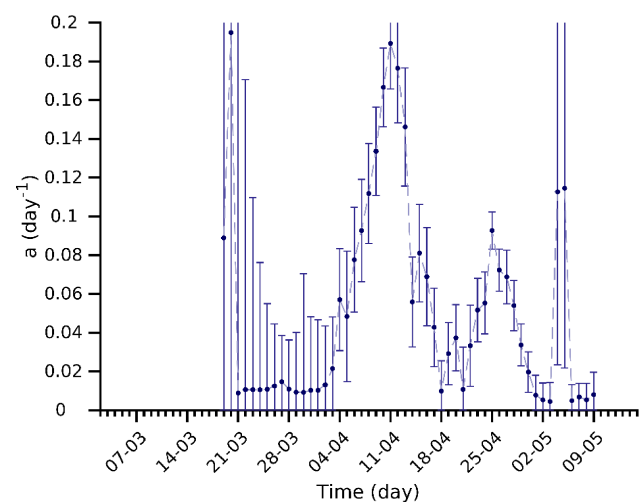
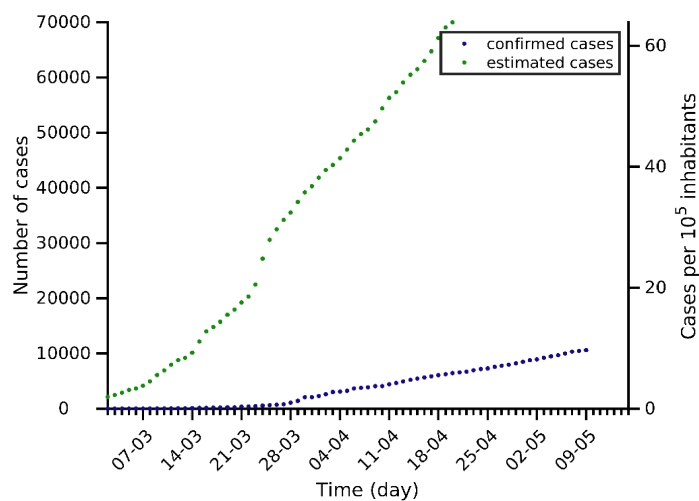
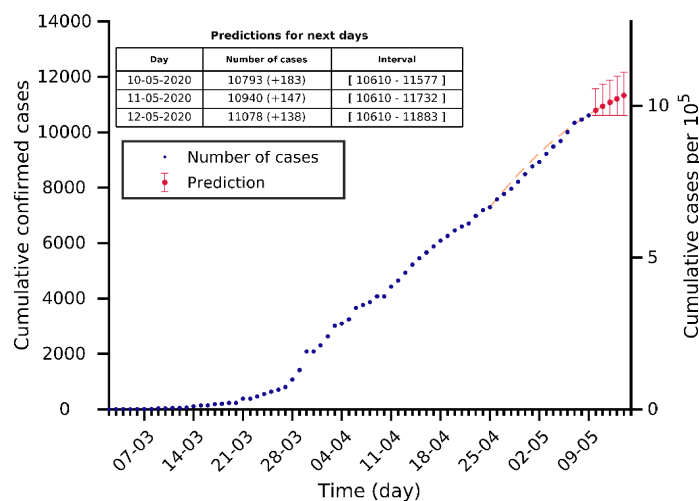
Japan 09-05-2020. Population: 126.5M. Current cumulated incidence: 12/10⁵



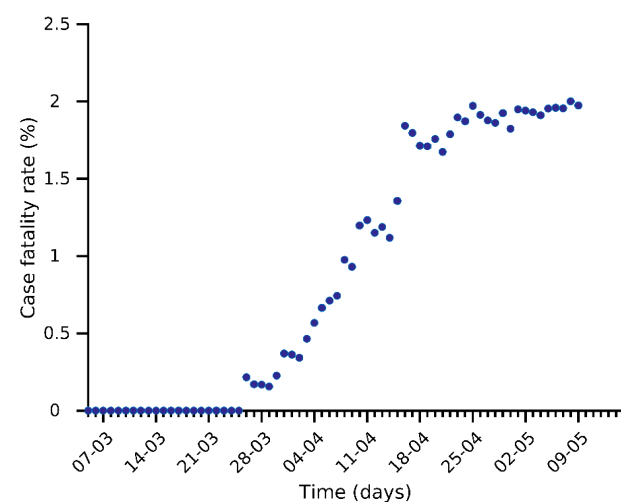
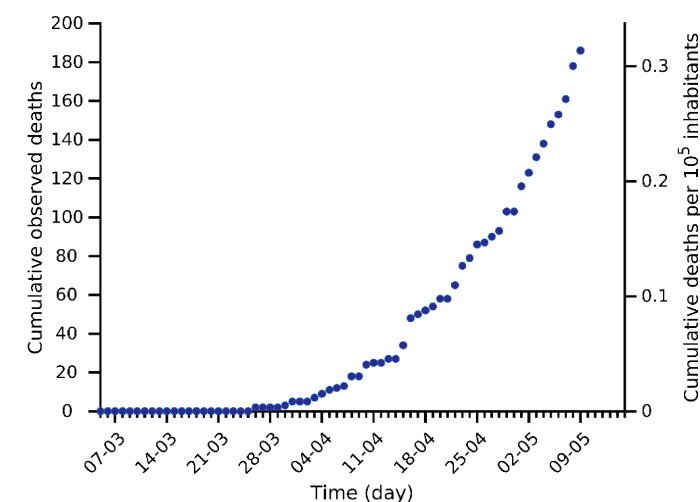
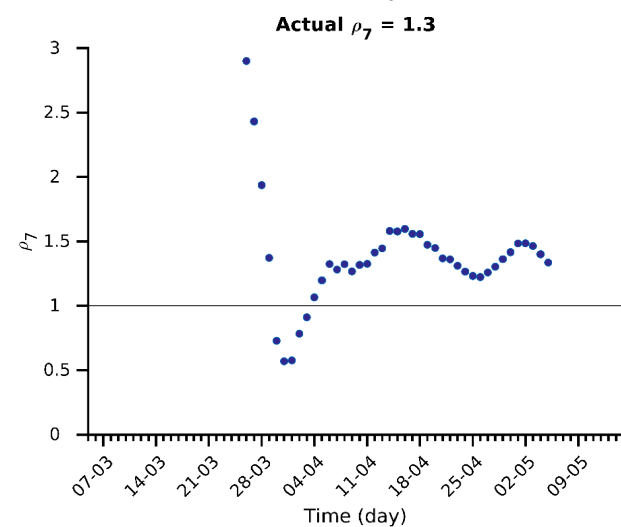
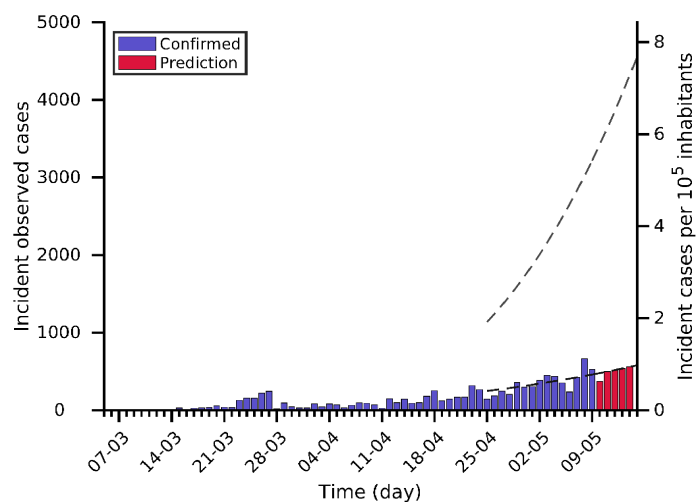
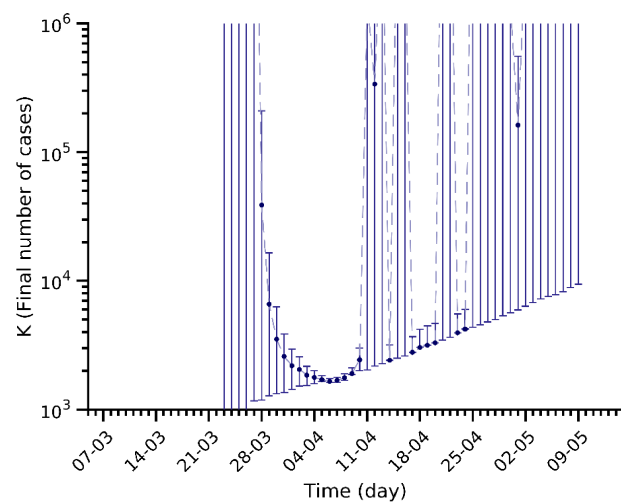
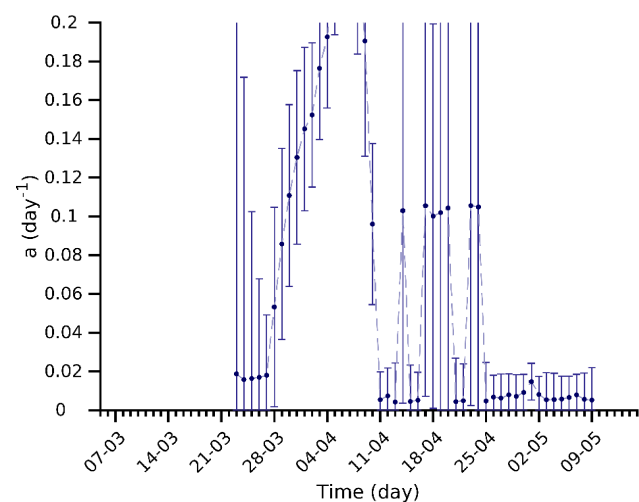
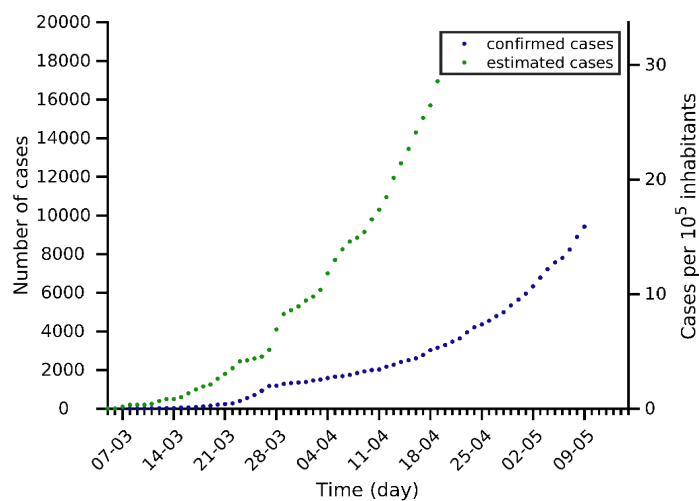
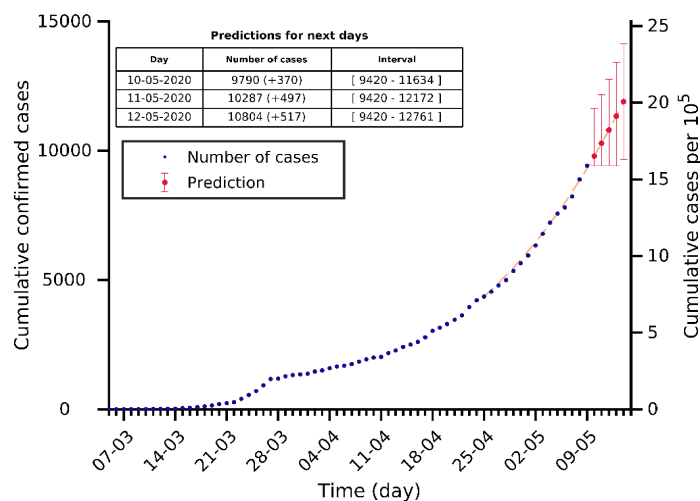
South Korea 09-05-2020. Population: 51.3M. Current cumulated incidence: 21/10⁵



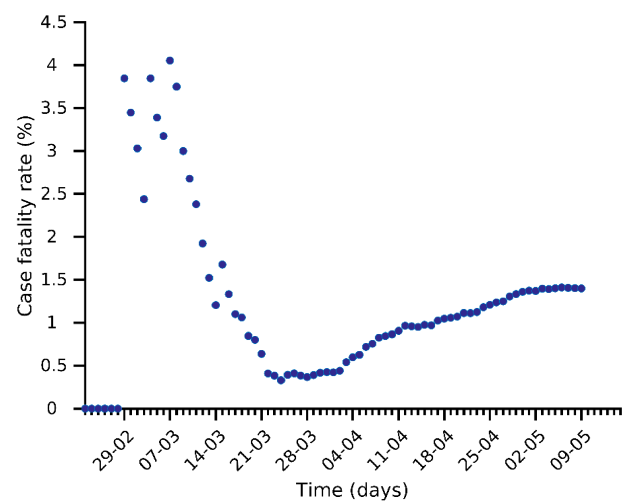
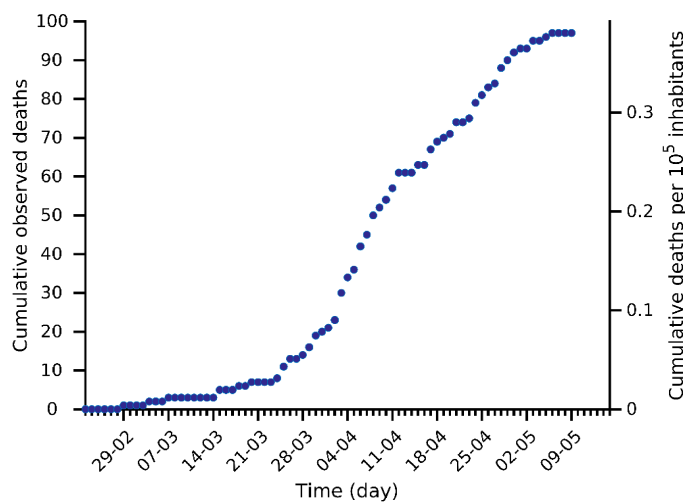
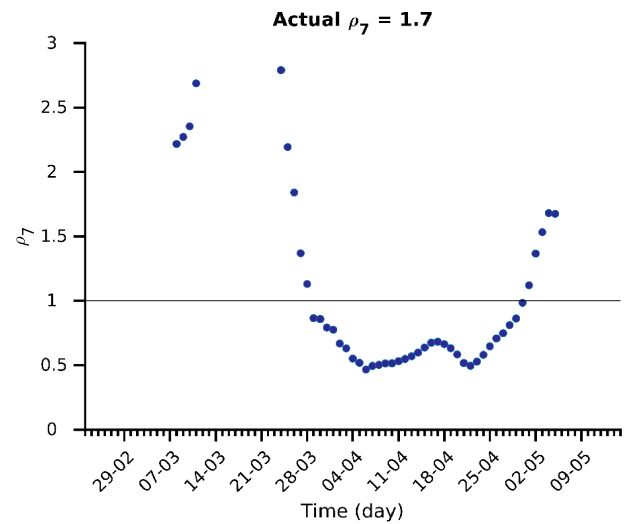
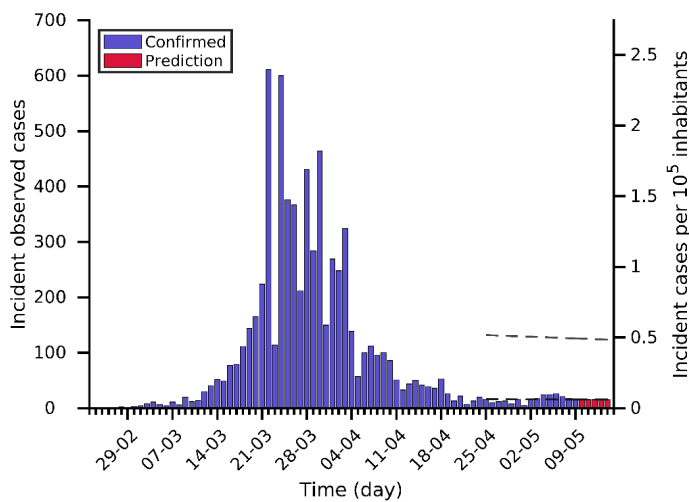
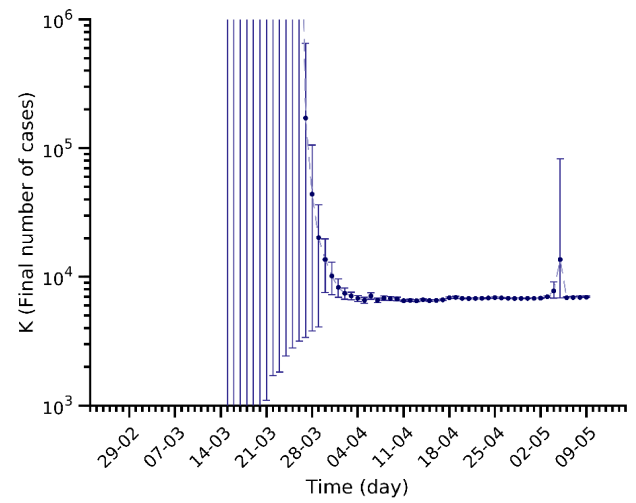
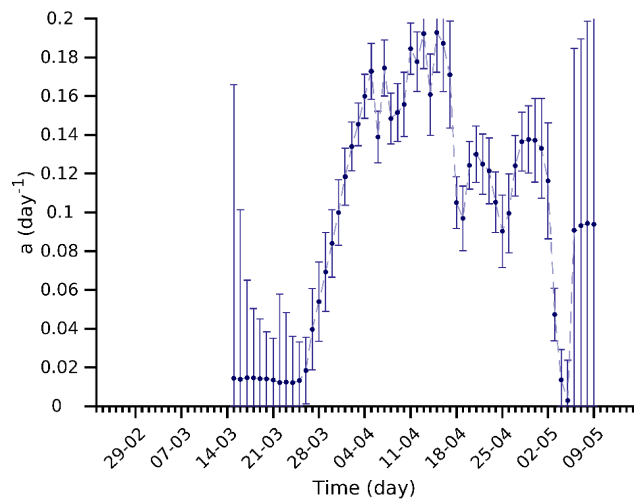
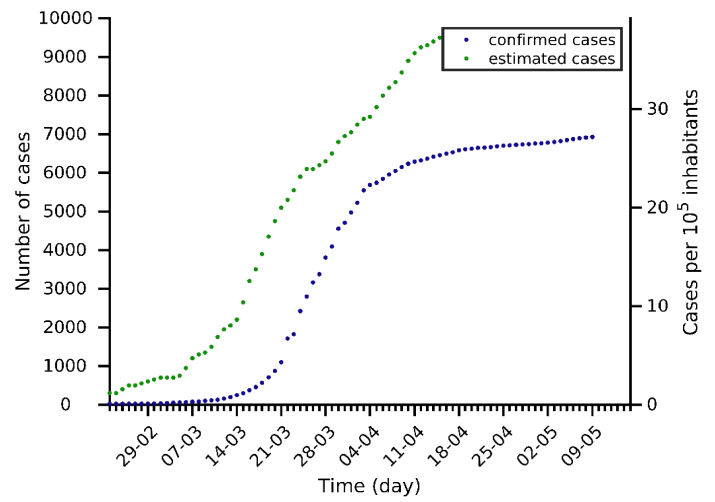
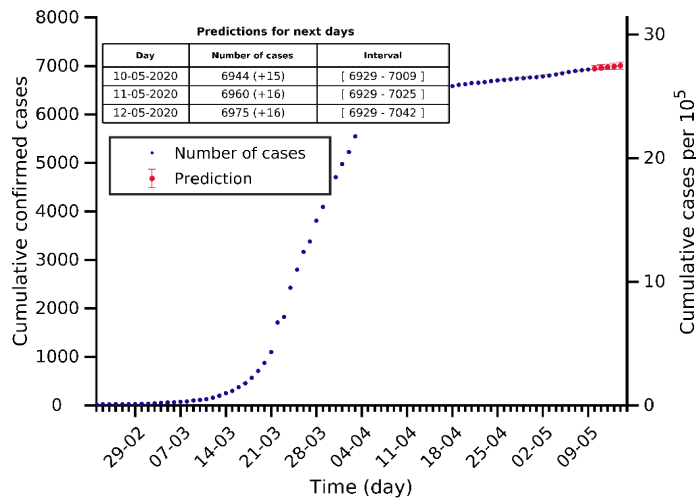
Philippines 09-05-2020. Population: 109.6M. Current cumulated incidence: 10/10⁵



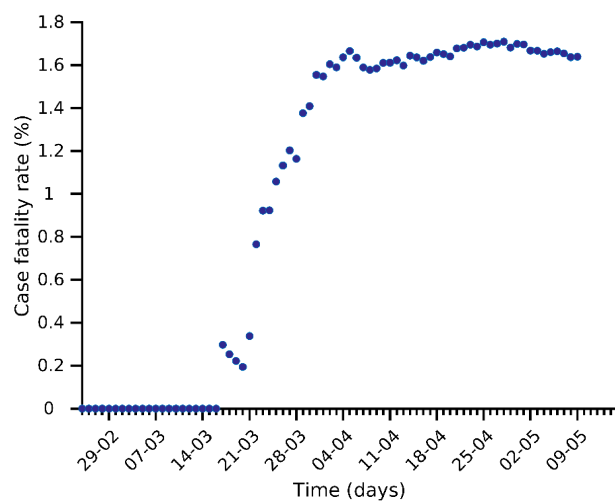
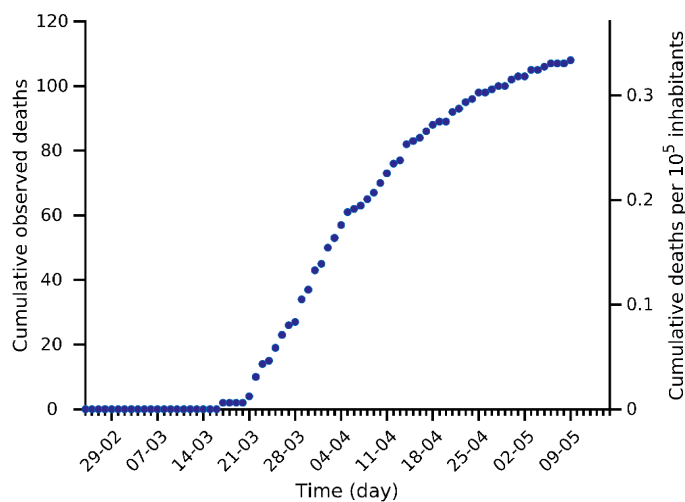
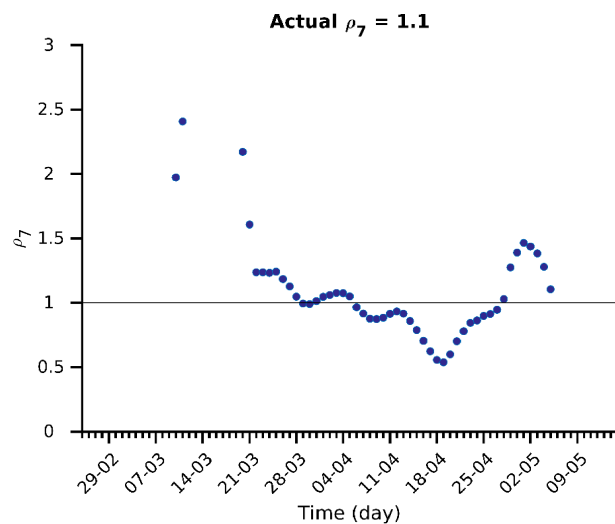
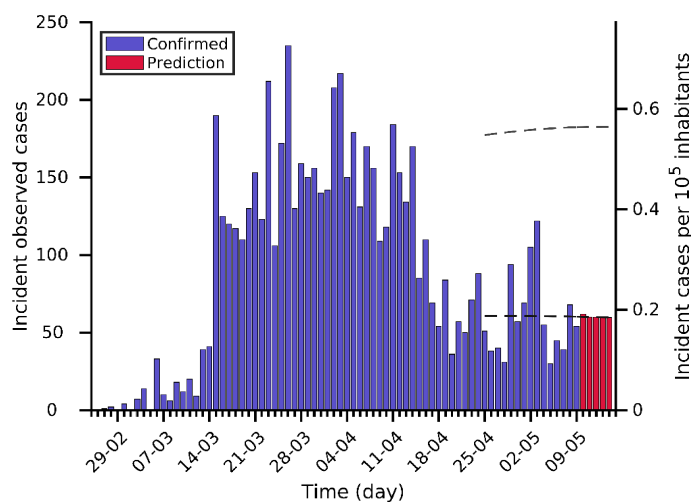
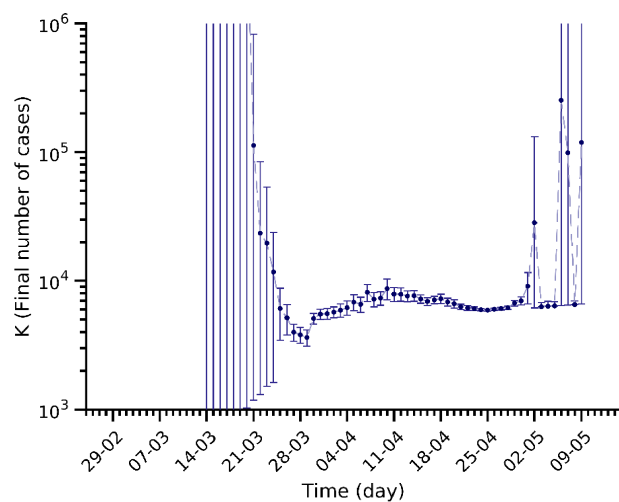
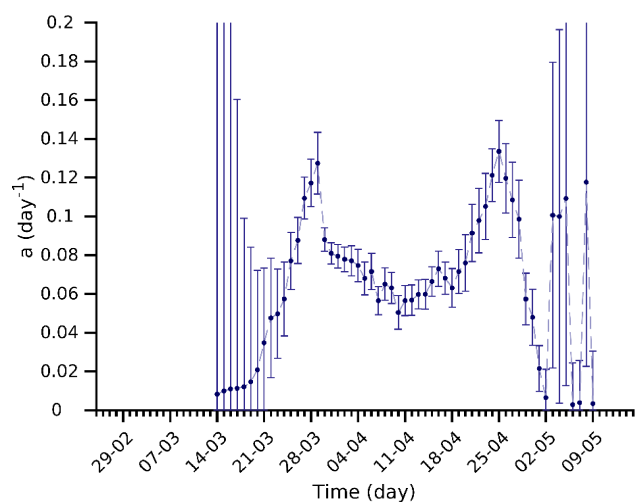
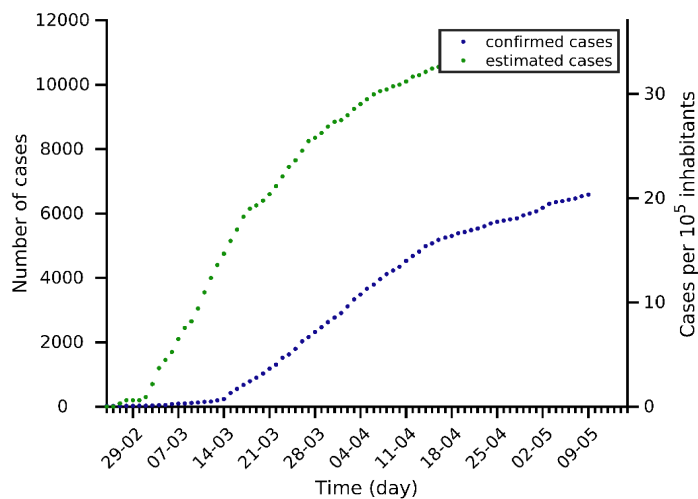
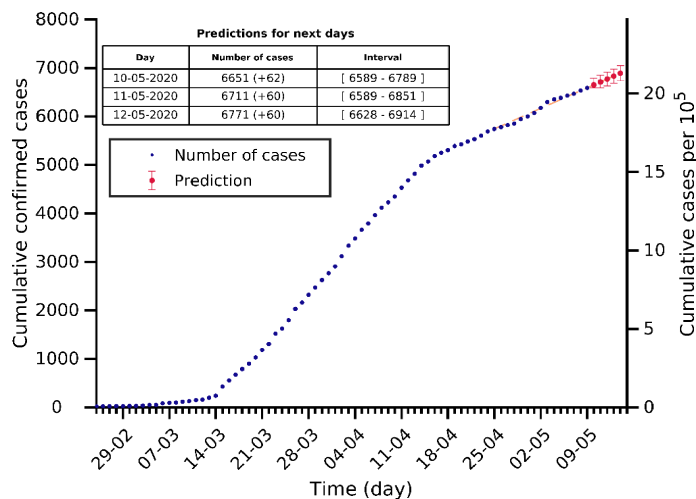
South Africa 09-05-2020. Population: 59.3M. Current cumulated incidence: 16/10⁵



Australia 09-05-2020. Population: 25.5M. Current cumulated incidence: 27/10⁵



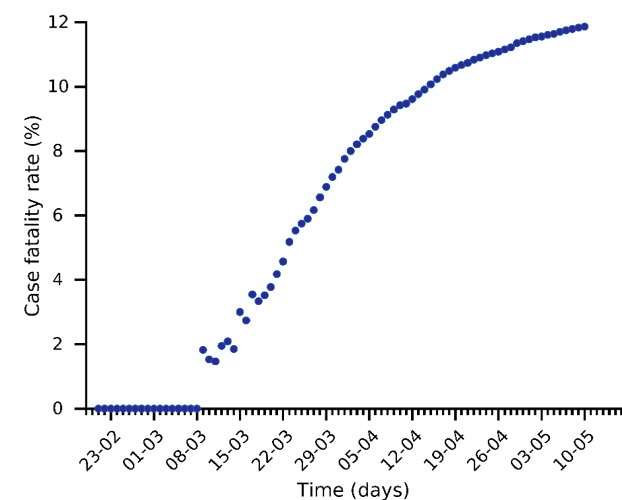
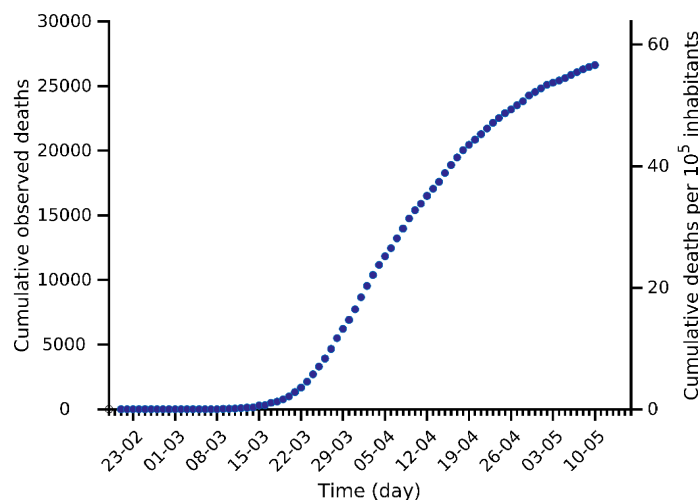
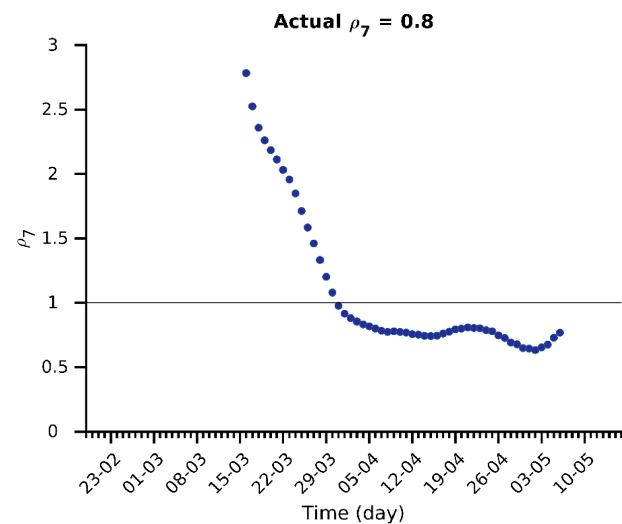
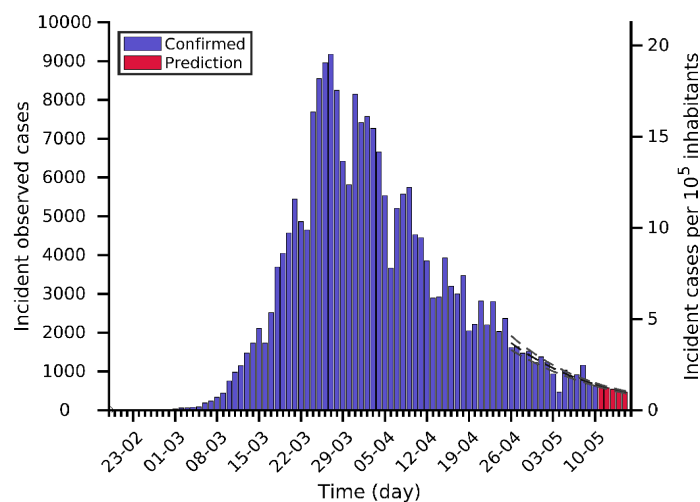
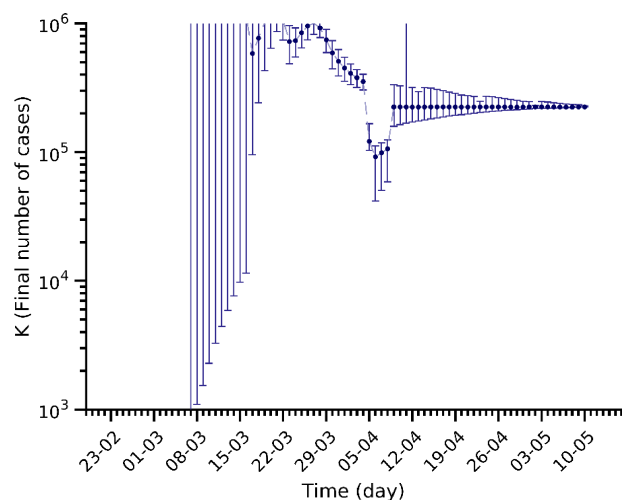
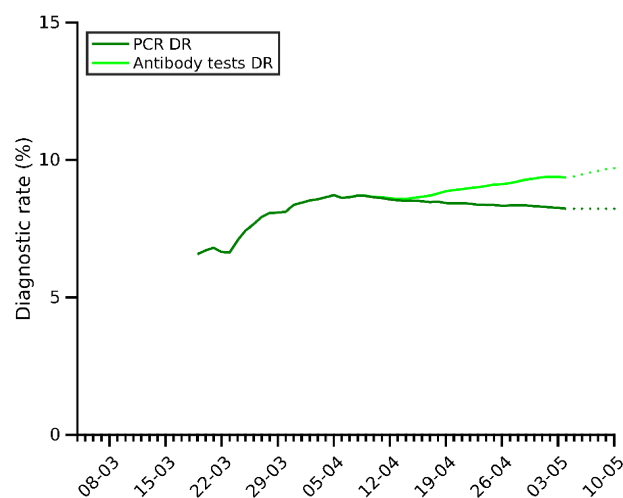
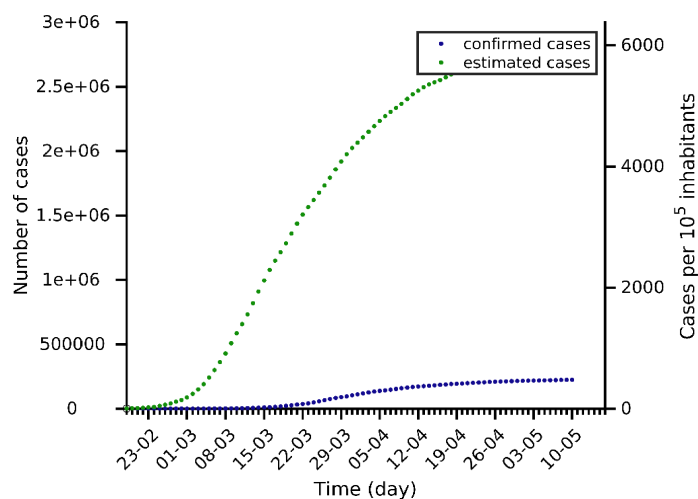
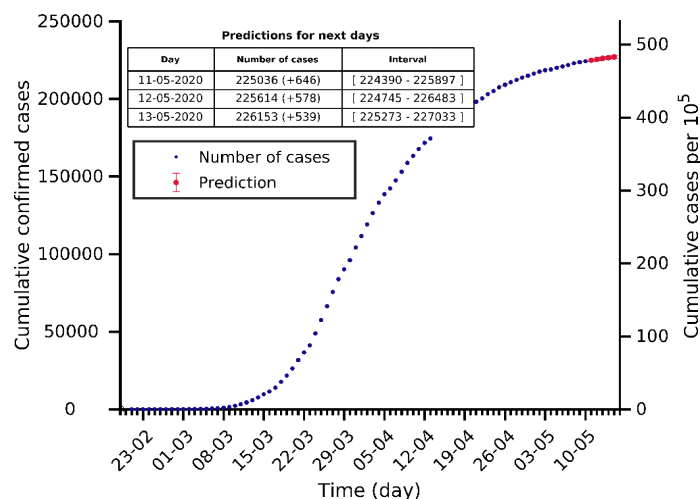
Malaysia 09-05-2020. Population: 32.4M. Current cumulated incidence: 20/10⁵



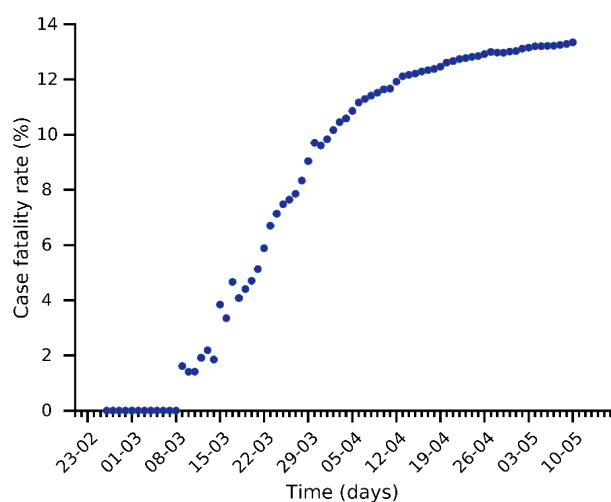
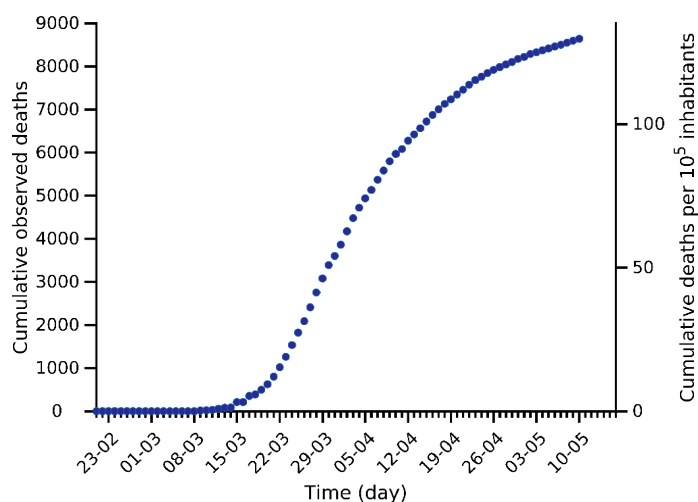
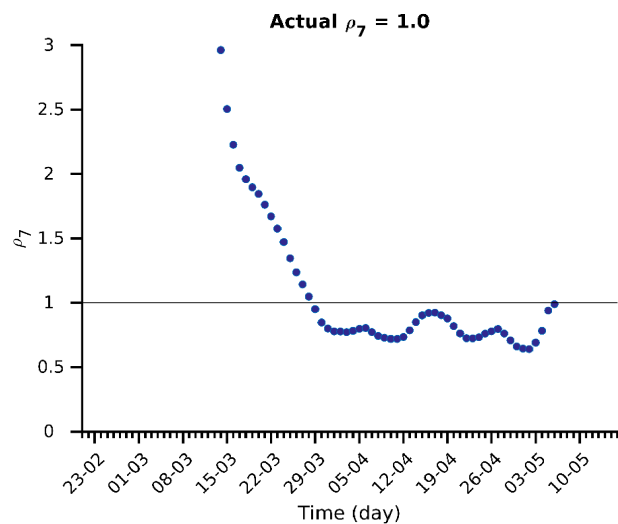
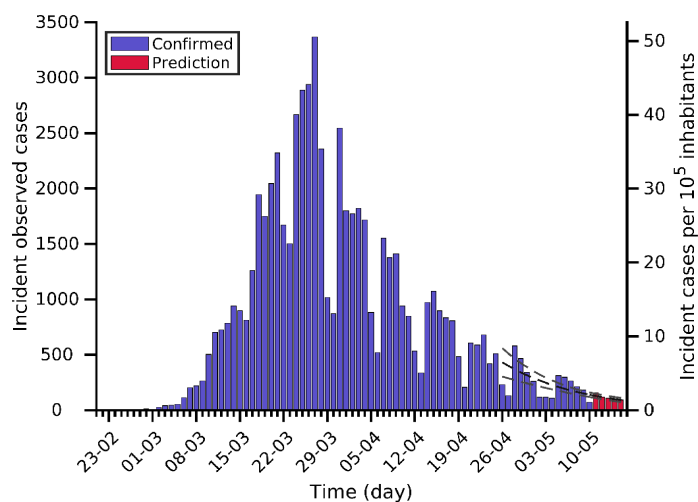
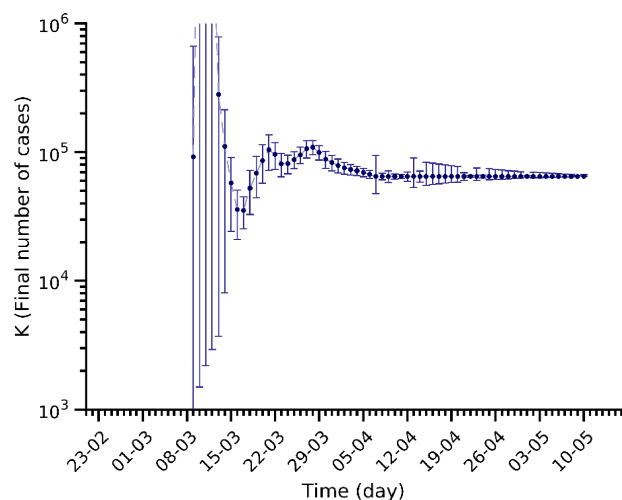
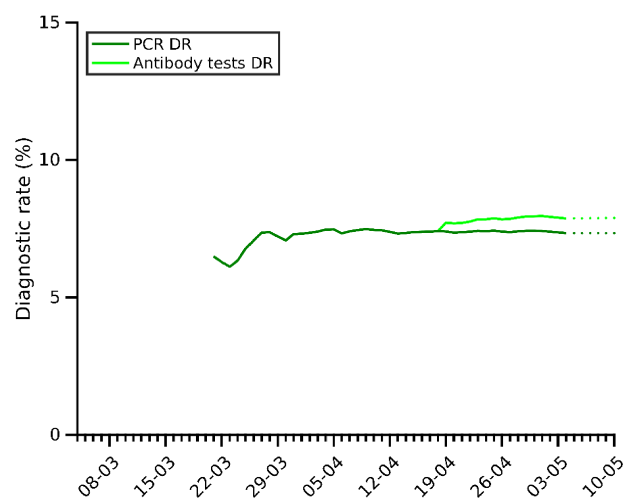
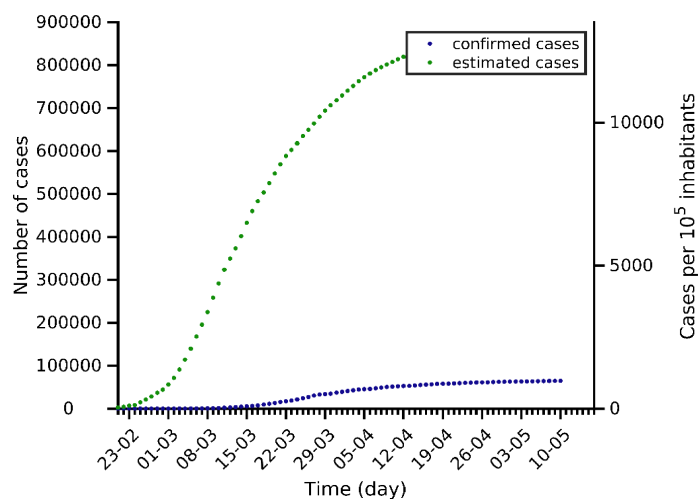
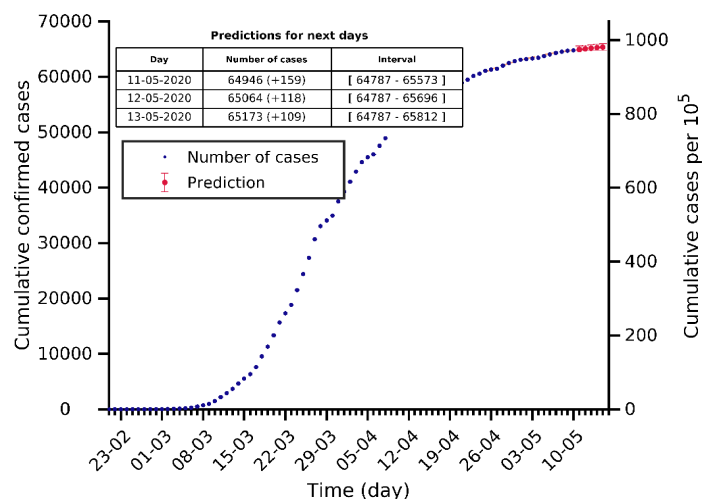
(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

Data obtained from <https://github.com/datadista/datasets/tree/master/COVID%2019> and
<https://covid19.isciii.es/>

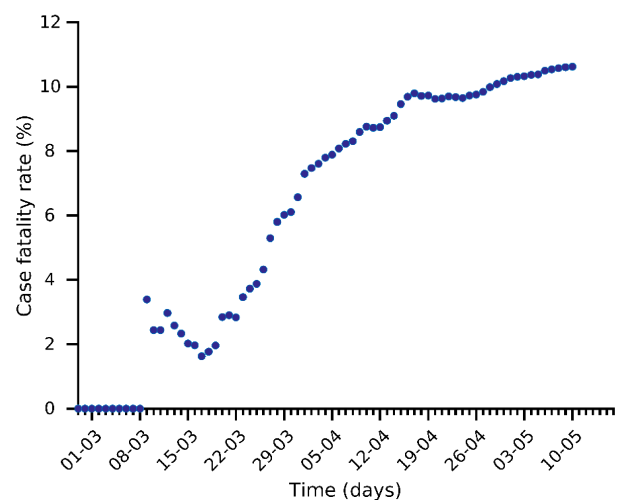
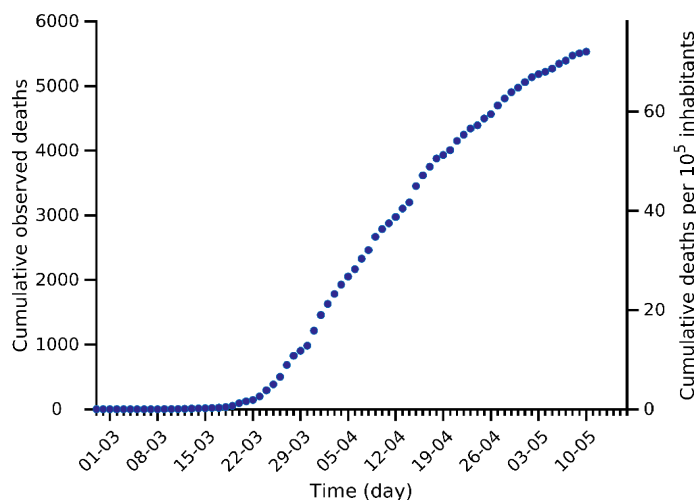
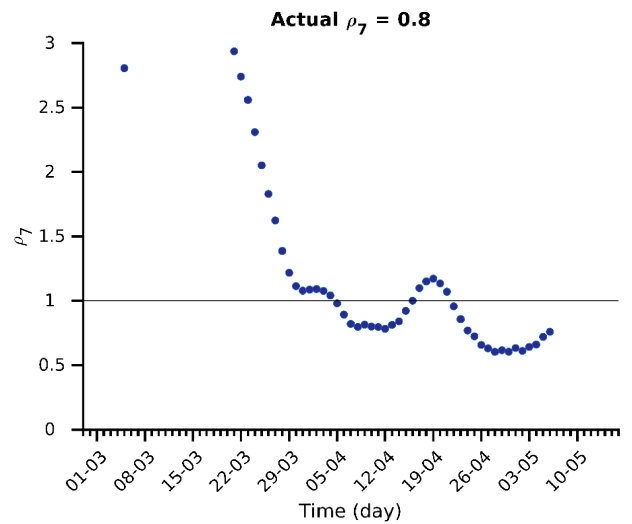
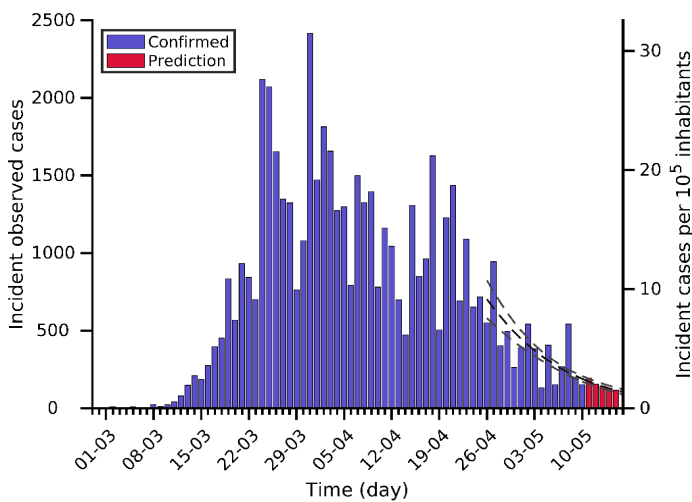
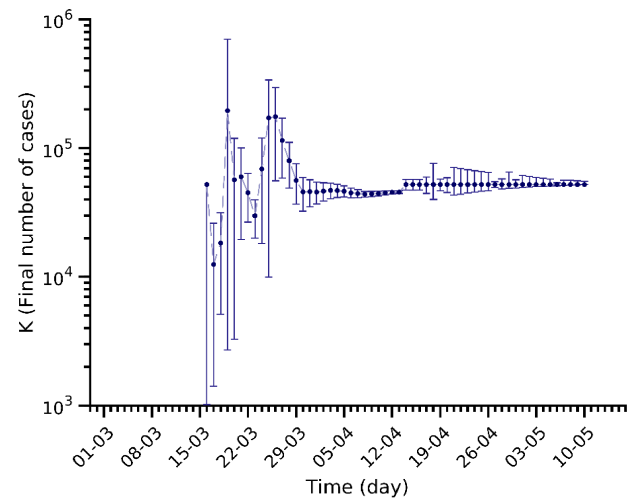
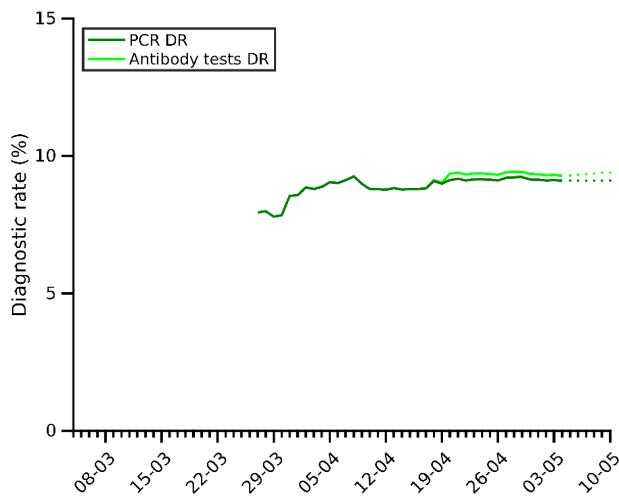
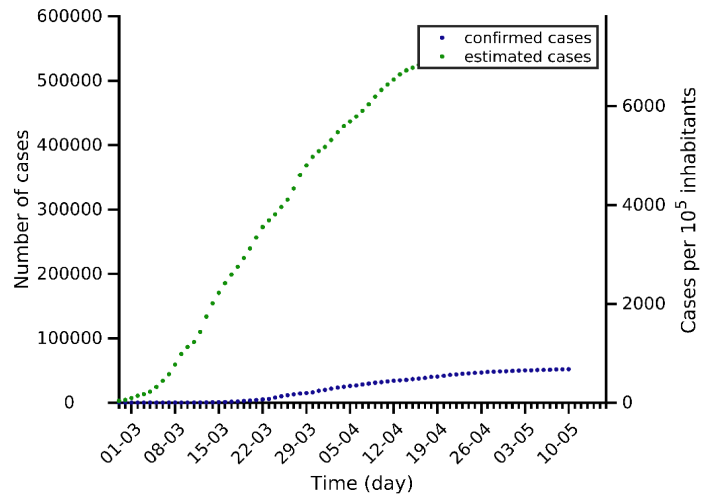
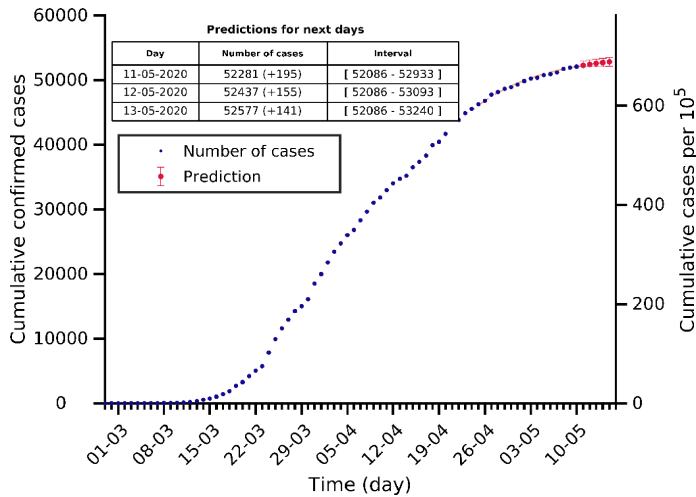
Spain 10-05-2020. Population: 47.0M. Current cumulated incidence: 477/10⁵



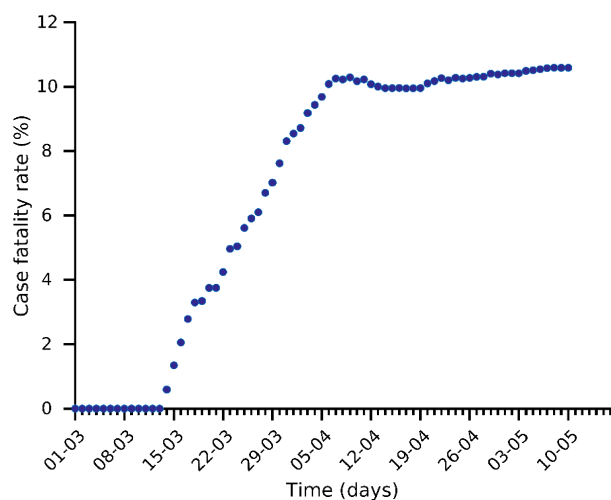
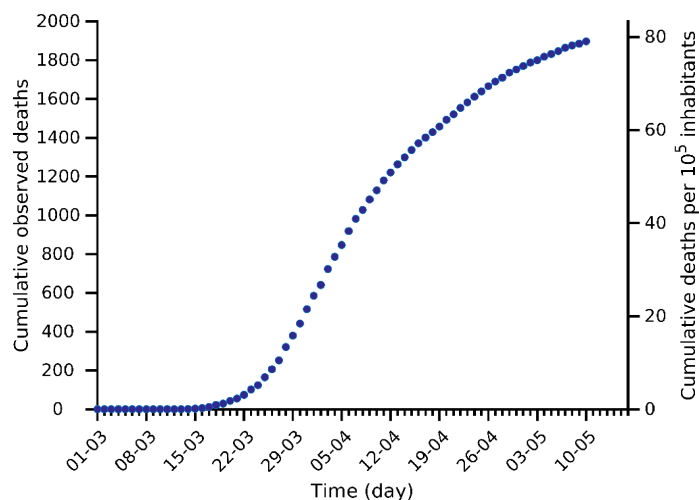
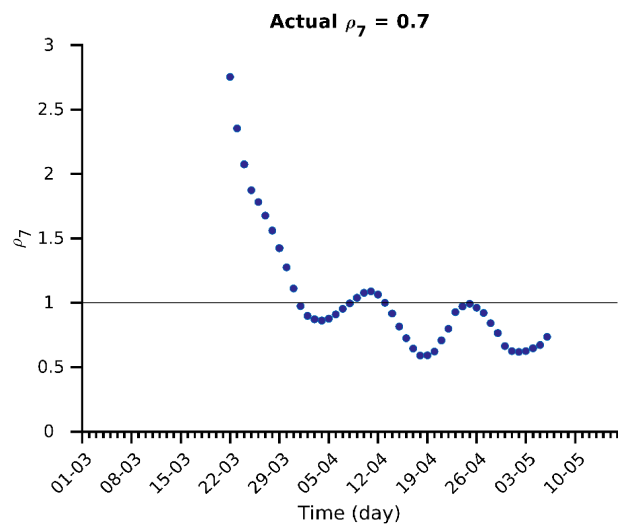
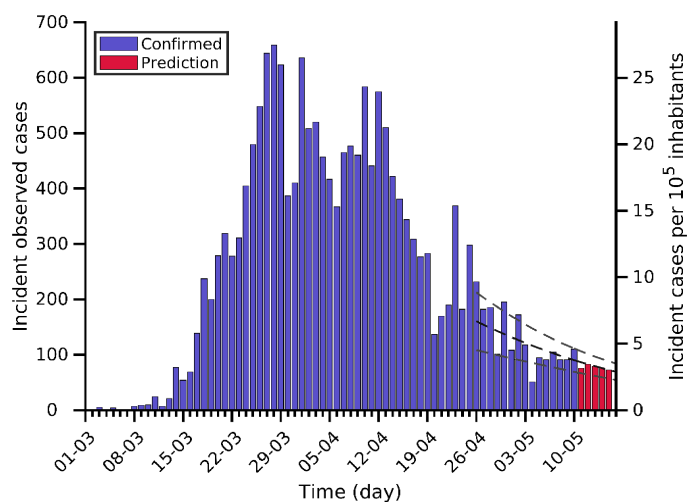
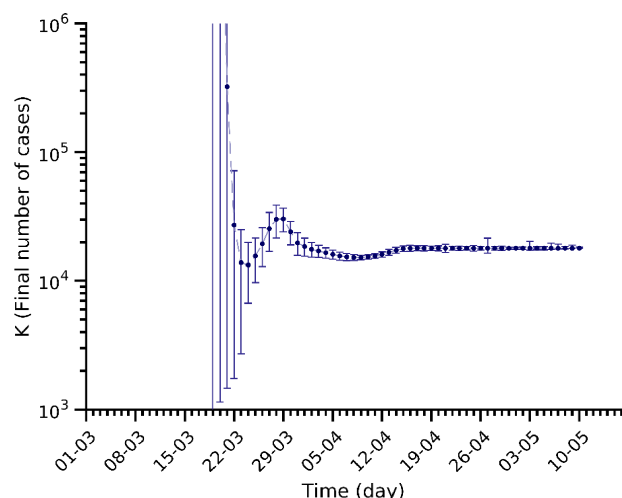
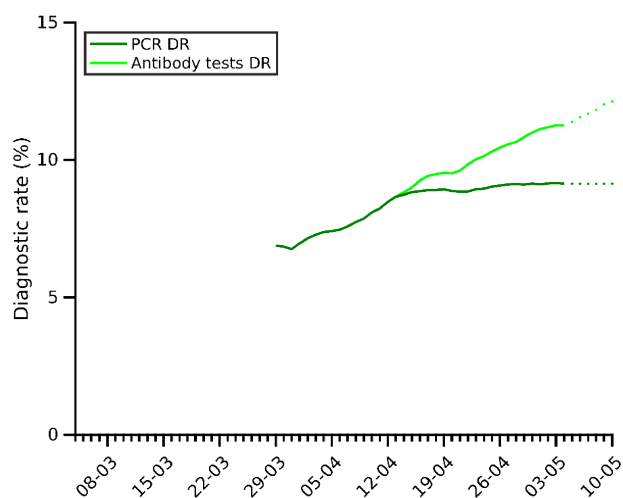
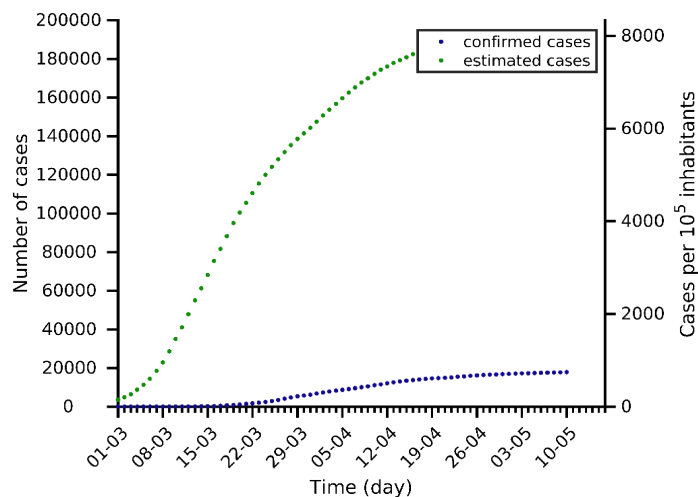
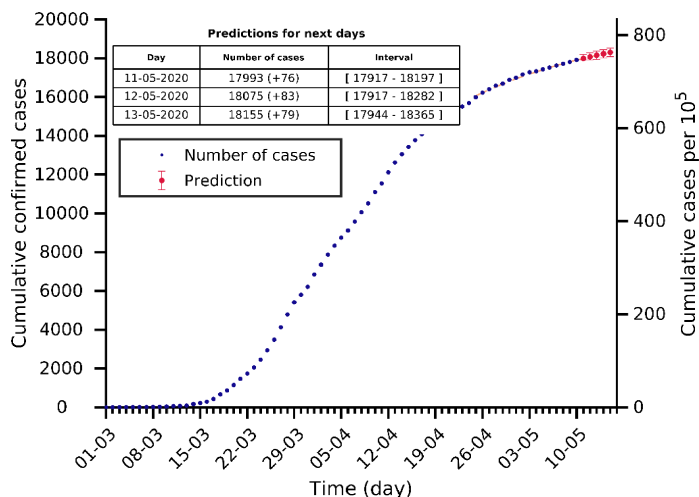
Madrid 10-05-2020. Population: 6.7M. Current cumulated incidence: 972/10⁵



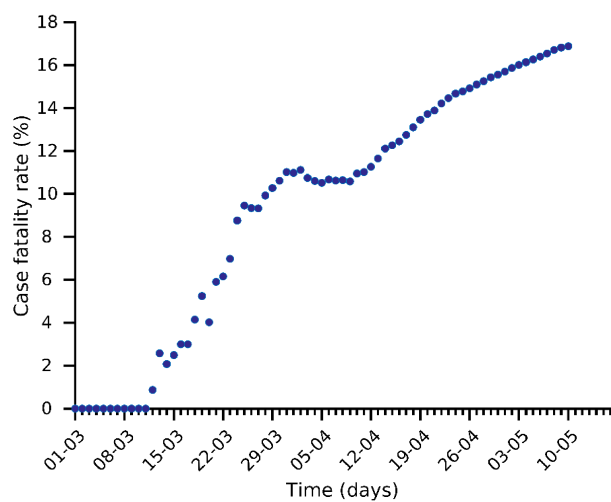
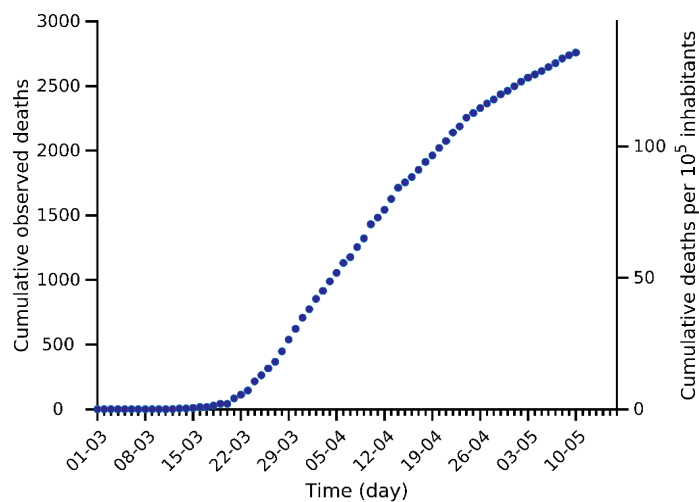
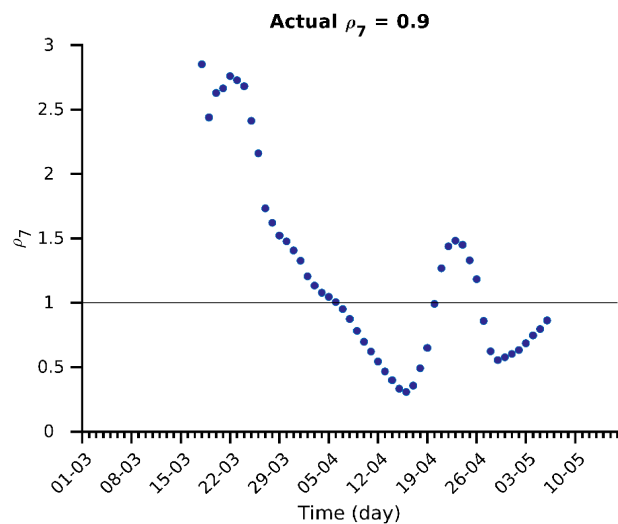
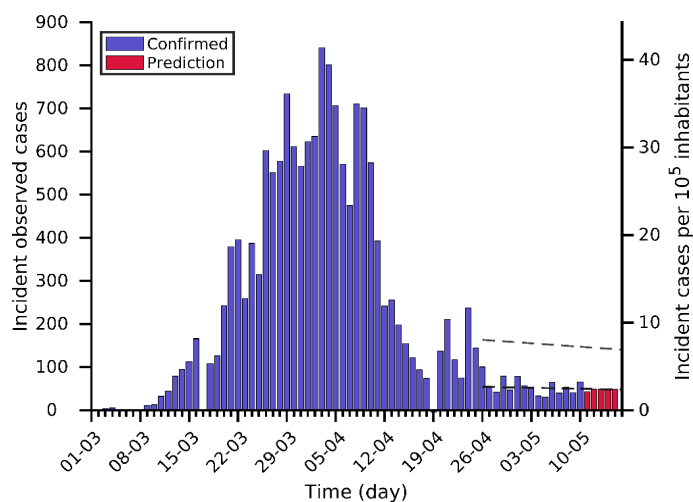
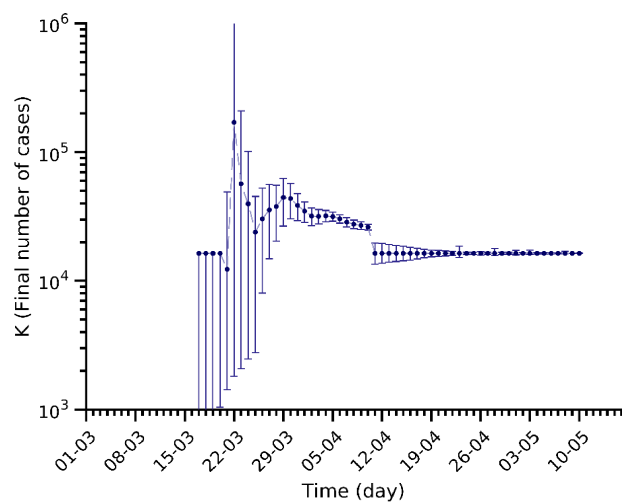
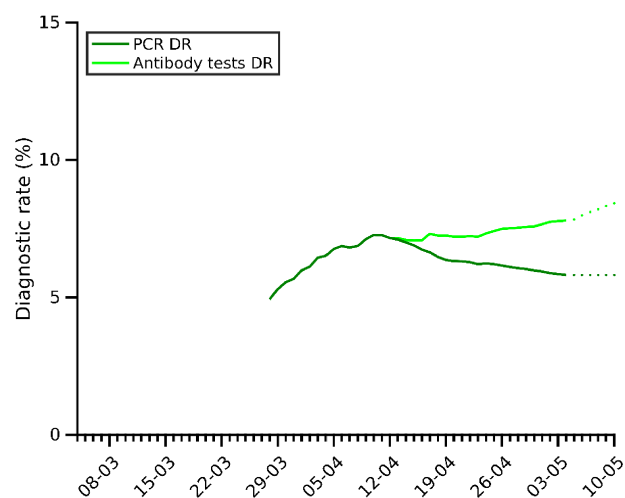
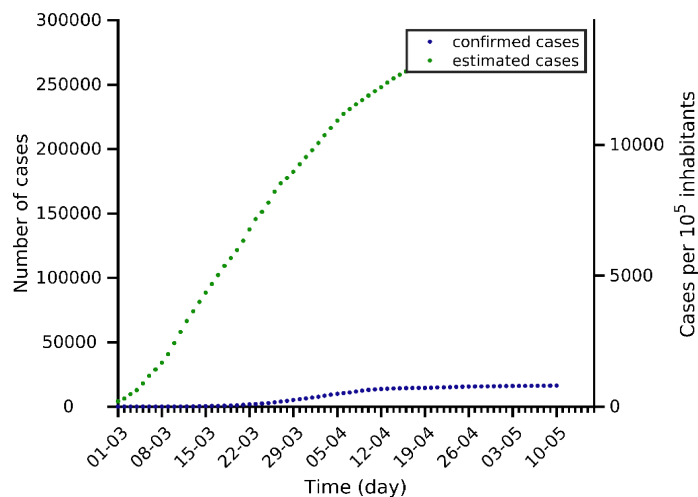
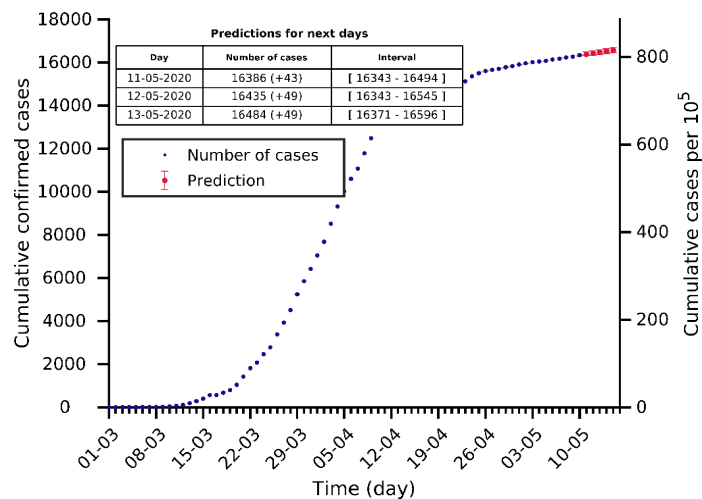
Catalunya 10-05-2020. Population: 7.7M. Current cumulated incidence: 679/10⁵



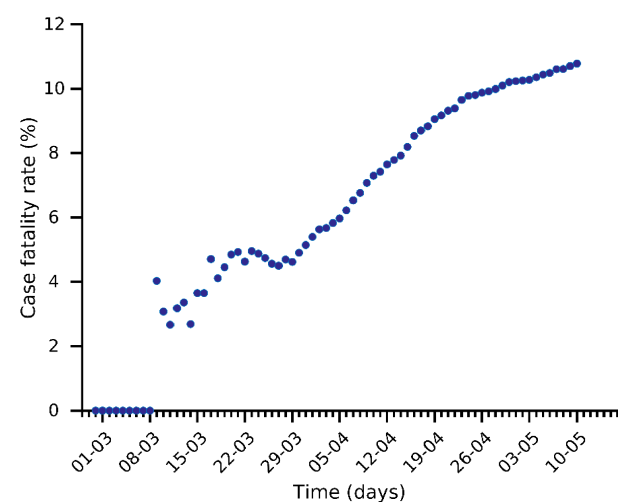
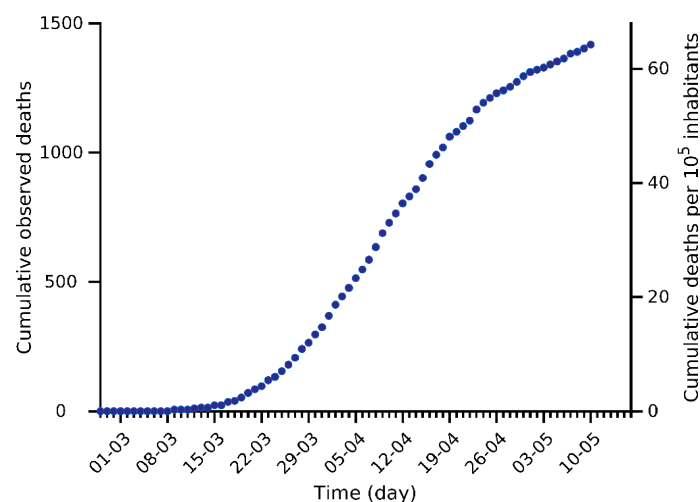
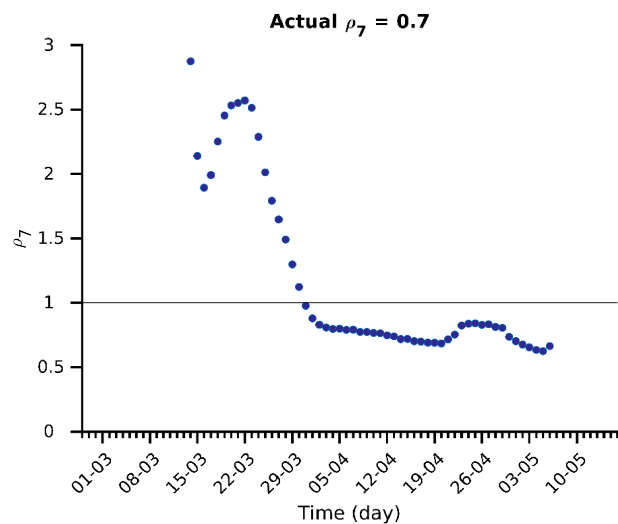
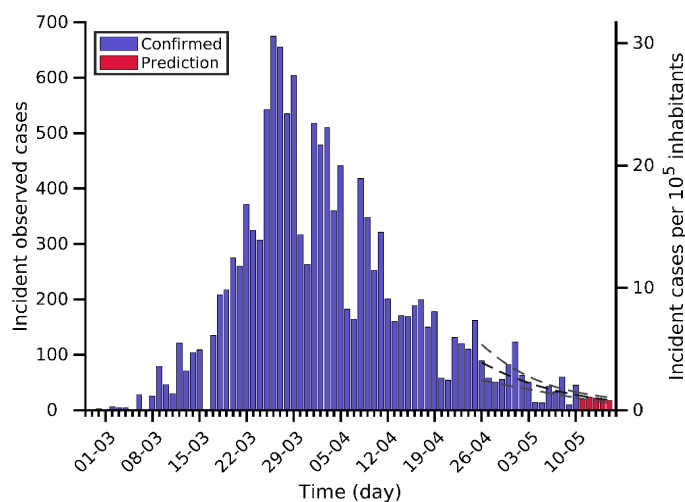
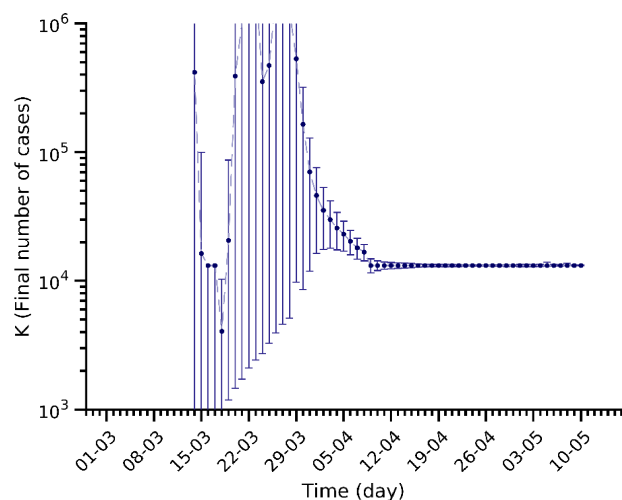
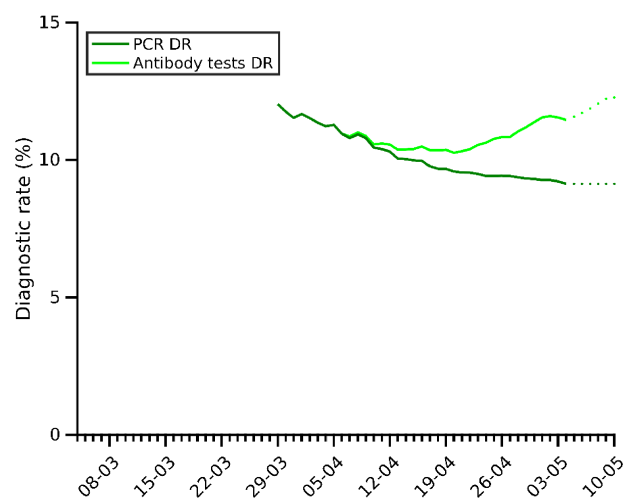
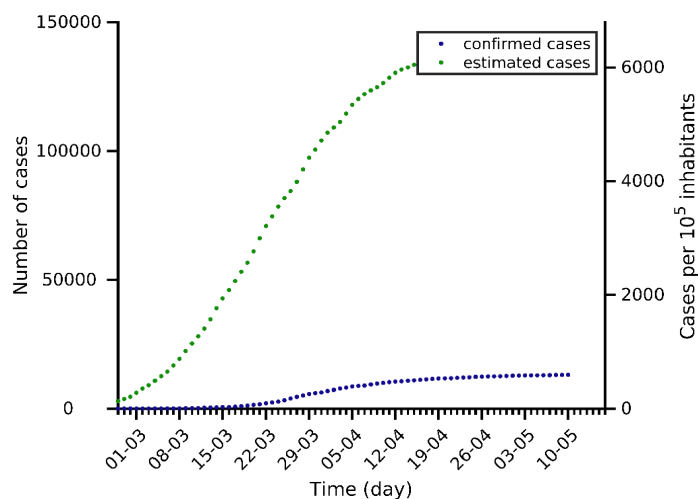
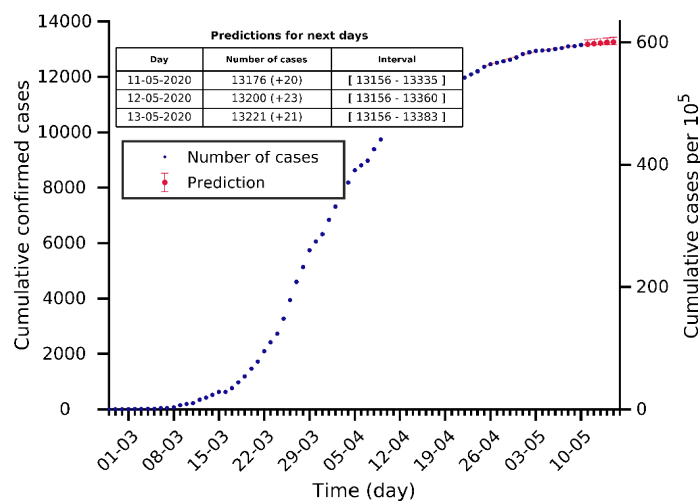
Castilla Leon 10-05-2020. Population: 2.4M. Current cumulated incidence: 747/10⁵



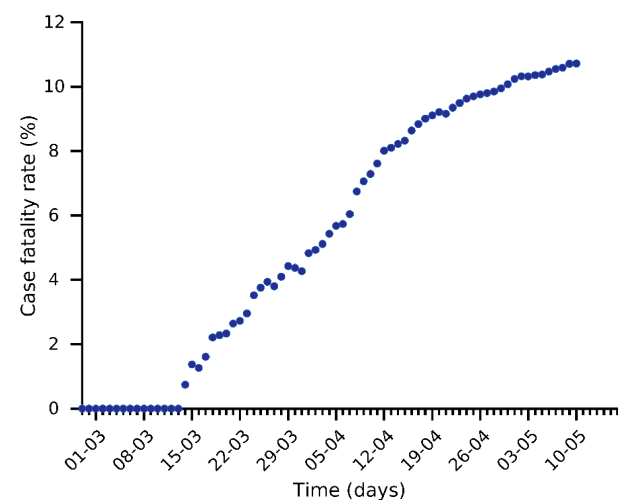
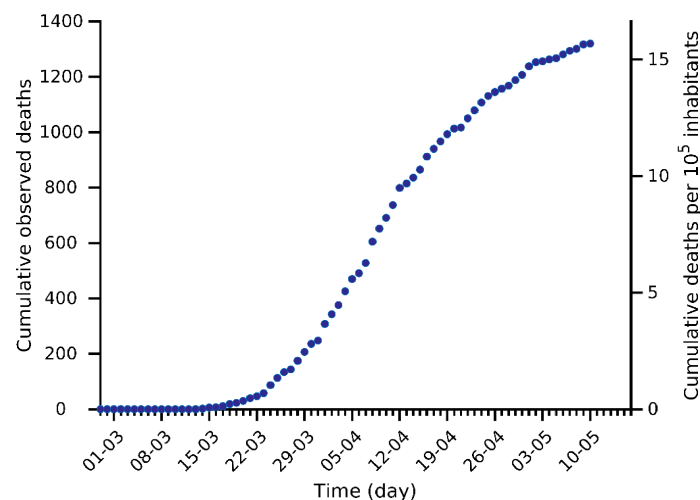
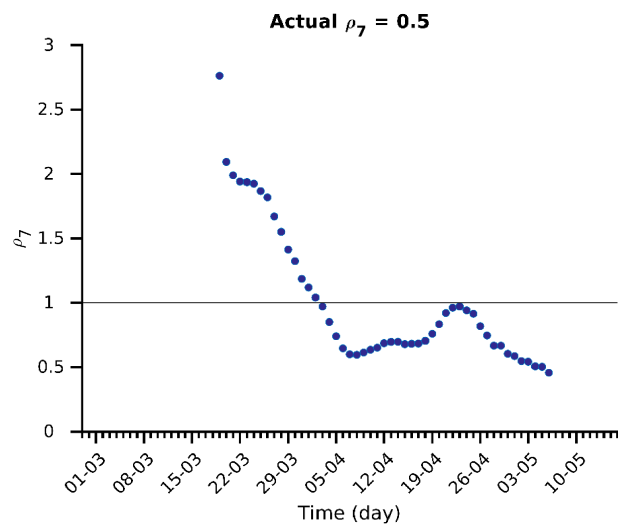
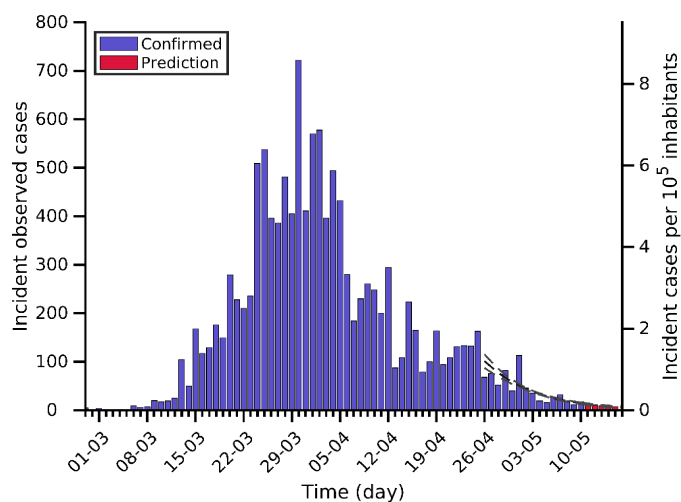
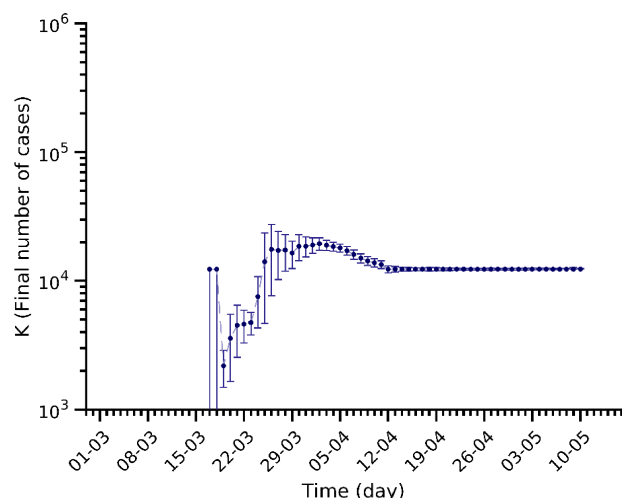
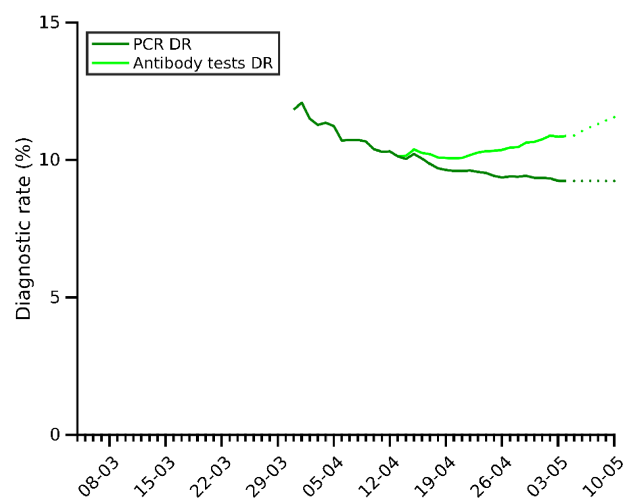
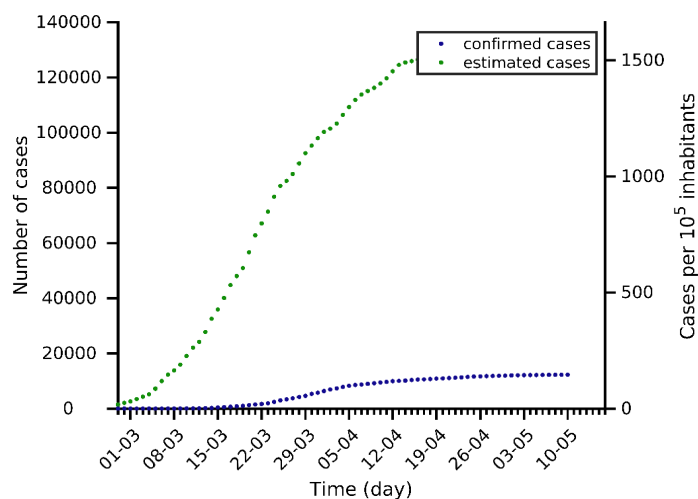
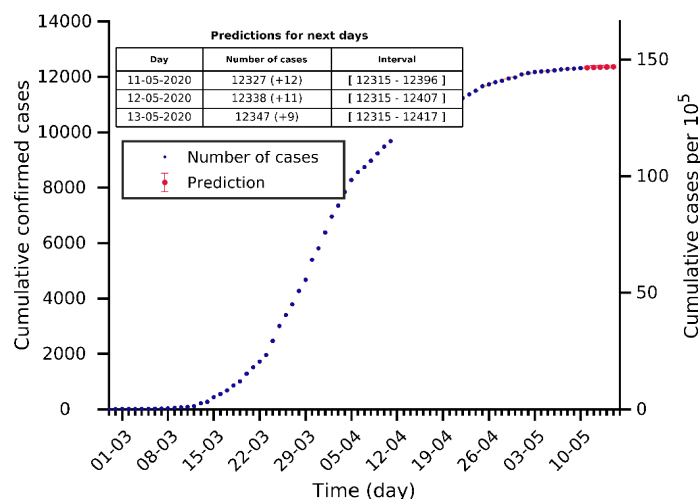
Castilla-La Mancha 10-05-2020. Population: 2.0M. Current cumulated incidence: 80



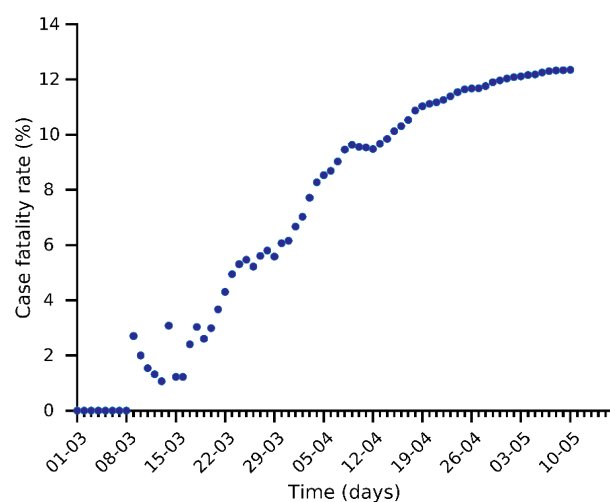
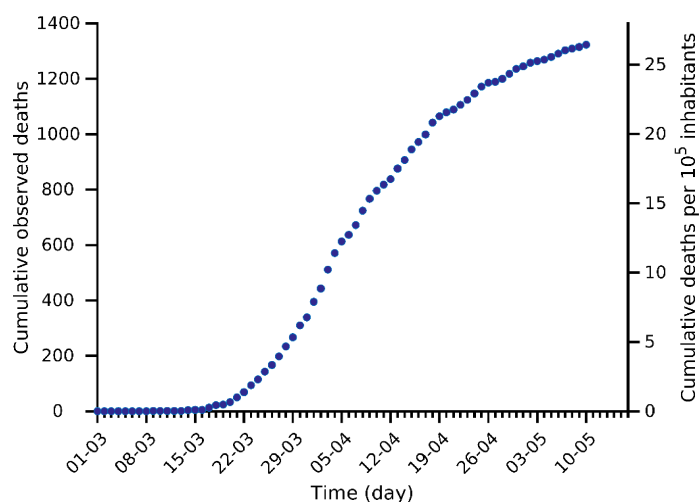
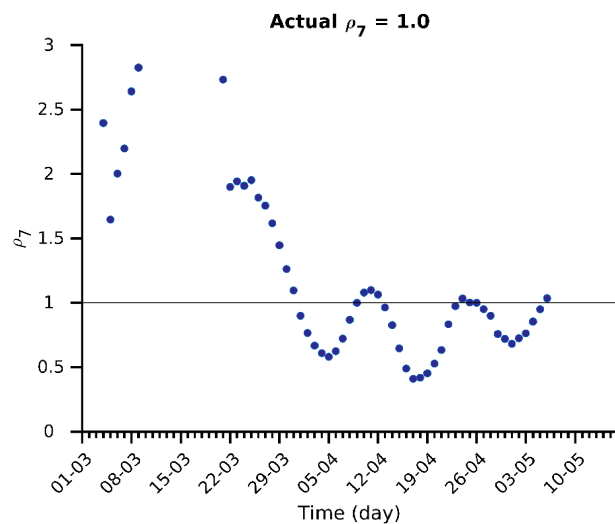
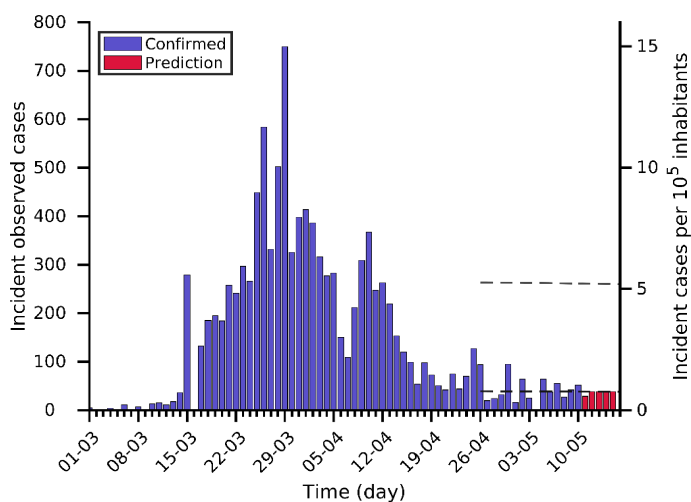
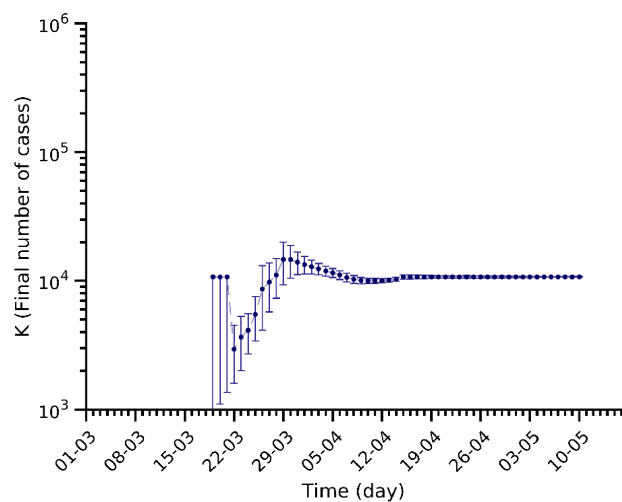
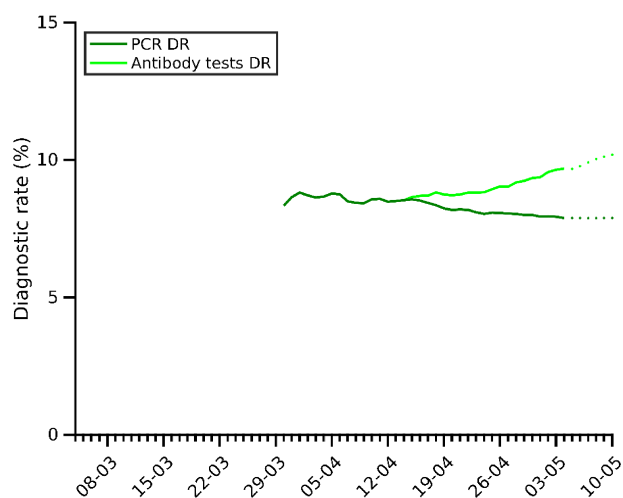
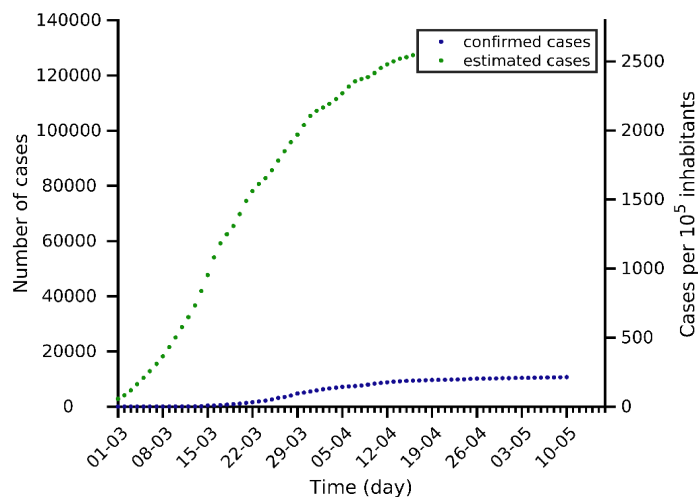
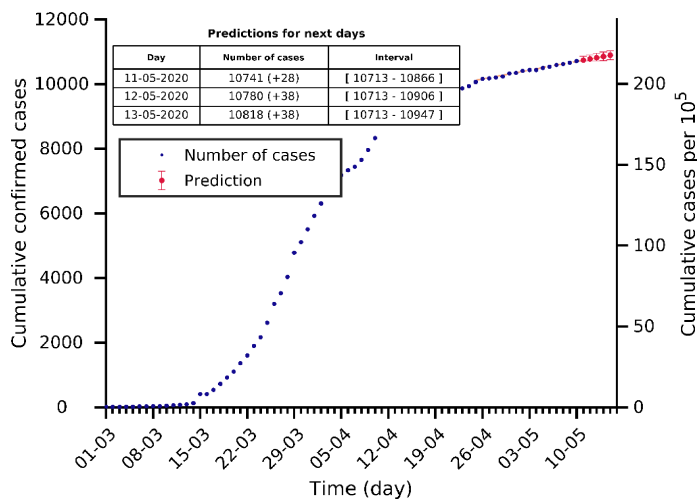
Euskadi 10-05-2020. Population: 2.2M. Current cumulated incidence: 596/10⁵



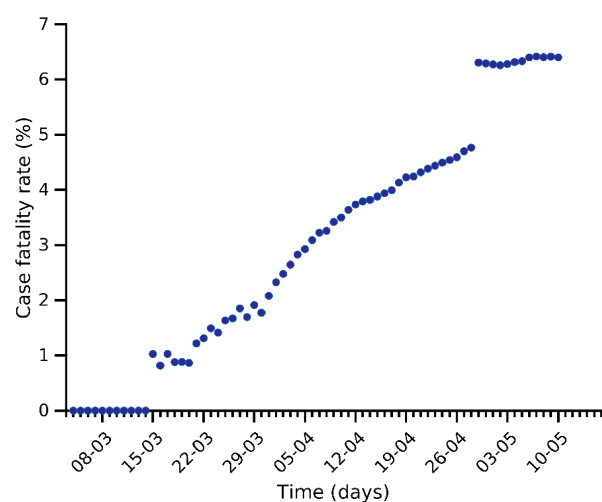
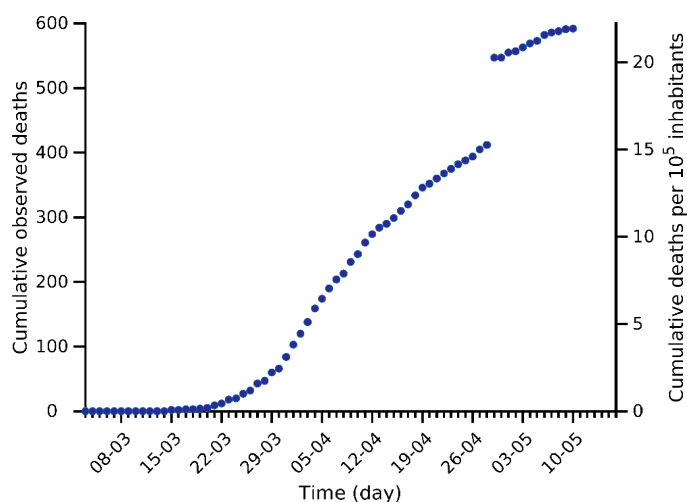
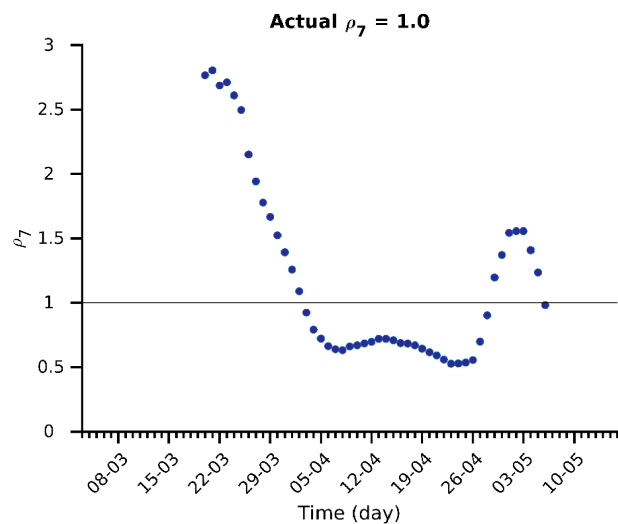
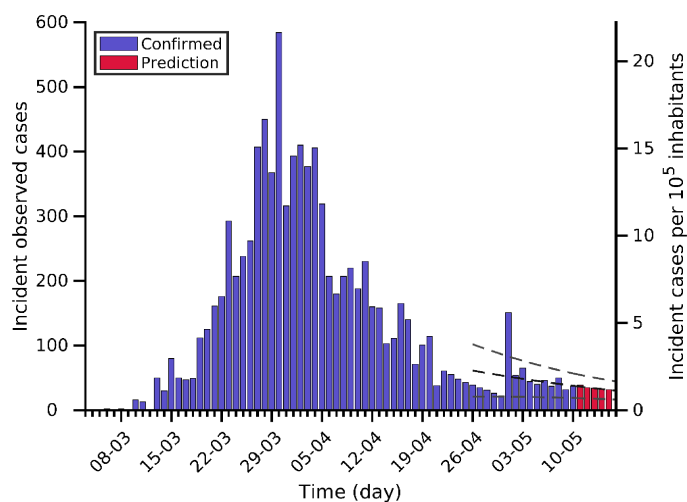
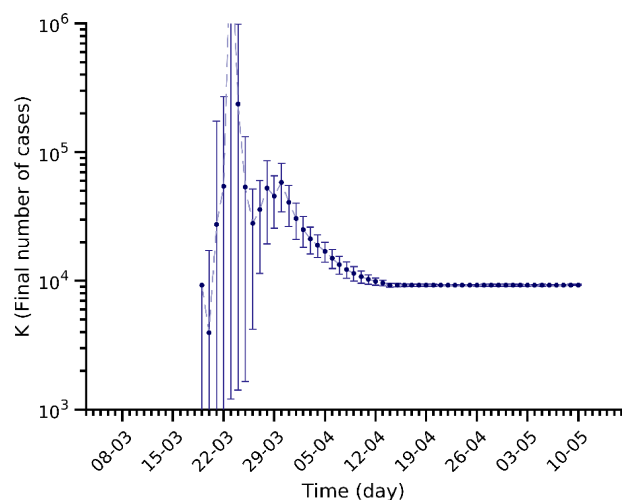
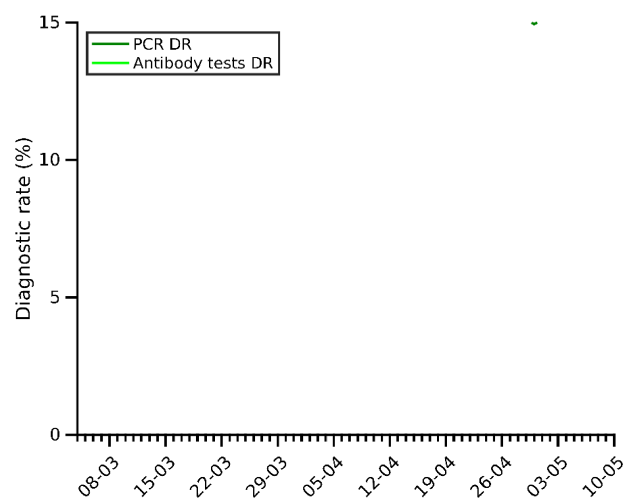
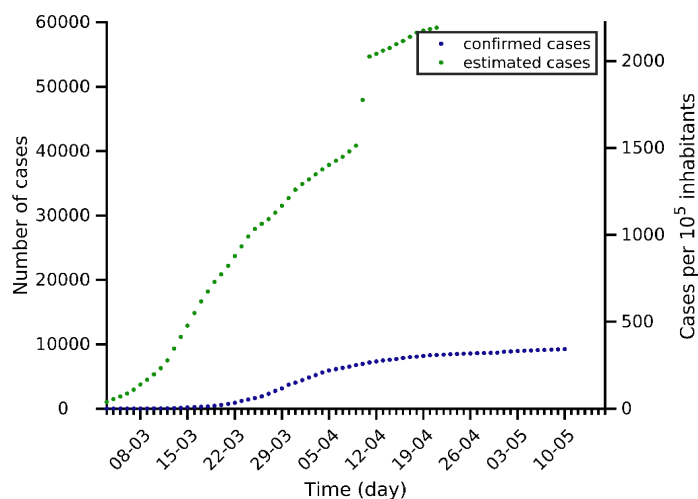
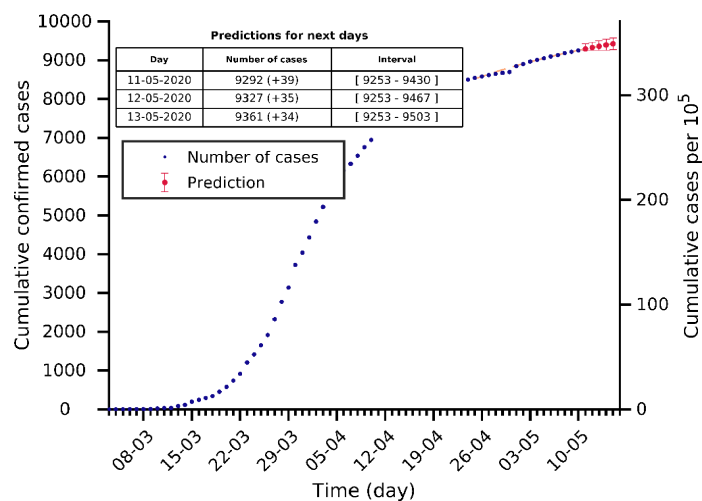
Andalucia 10-05-2020. Population: 8.4M. Current cumulated incidence: 146/10⁵



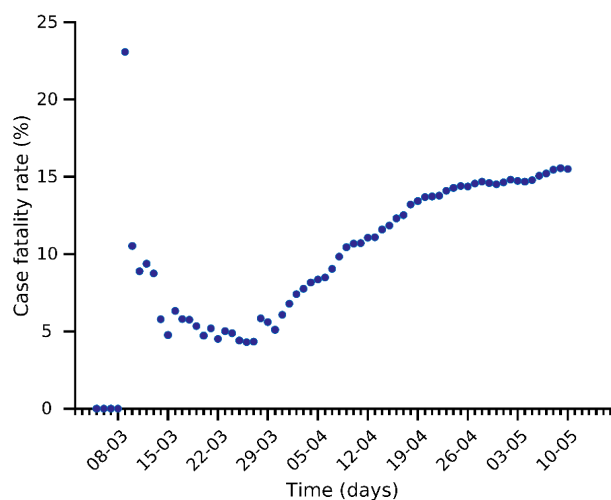
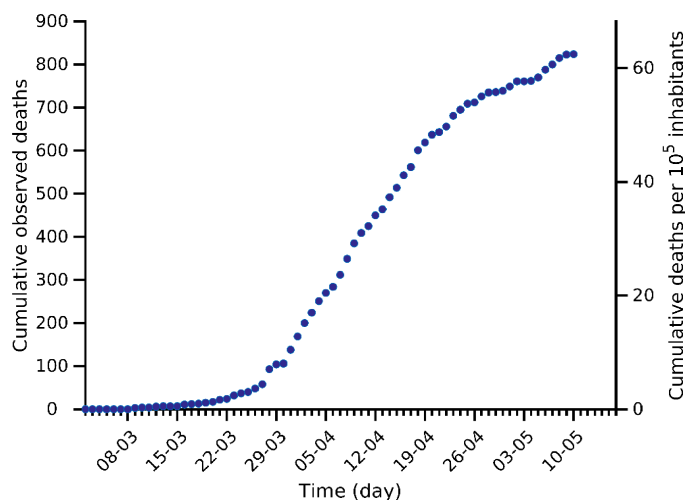
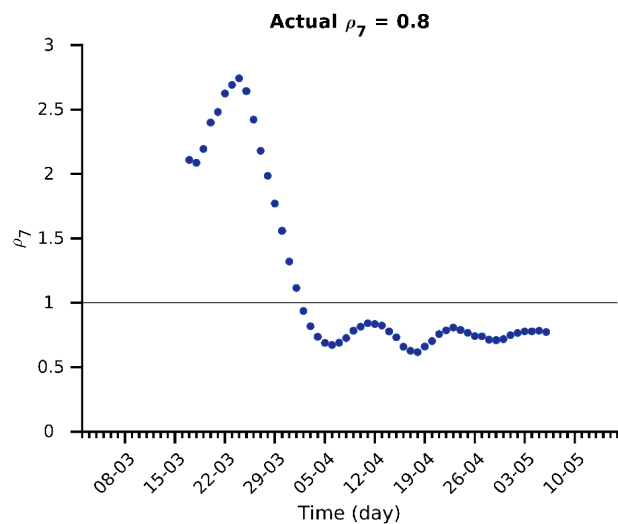
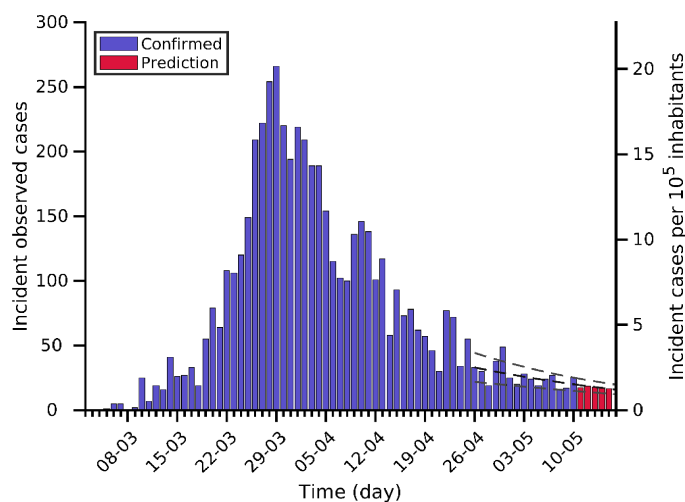
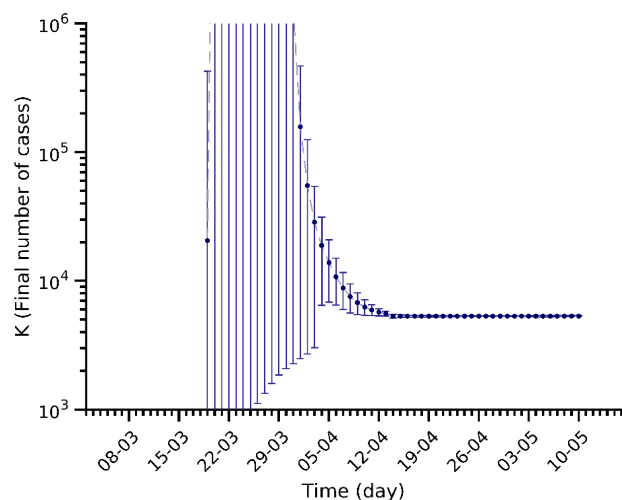
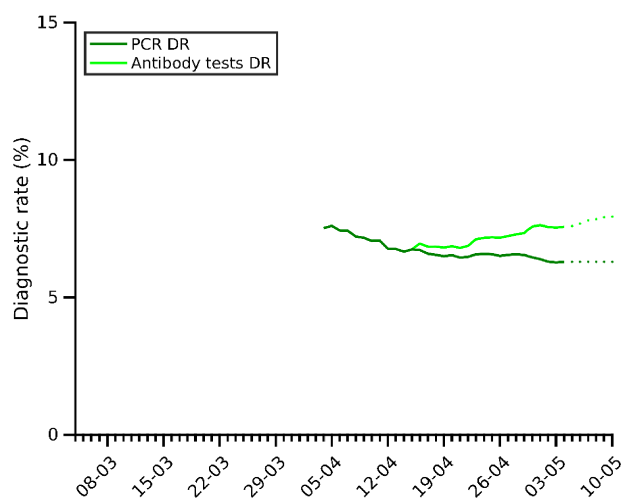
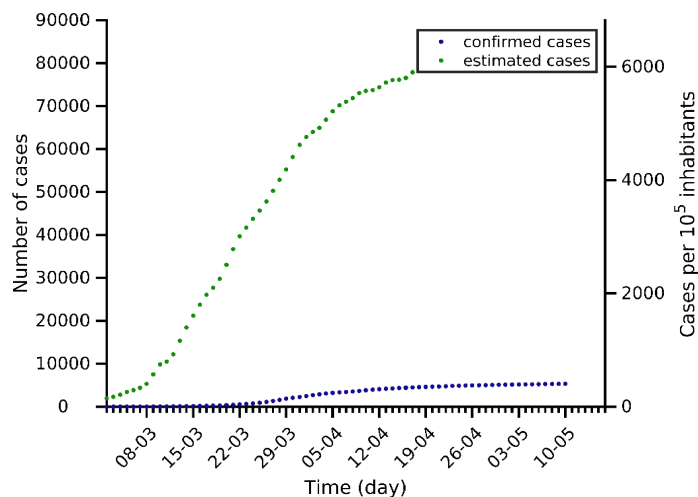
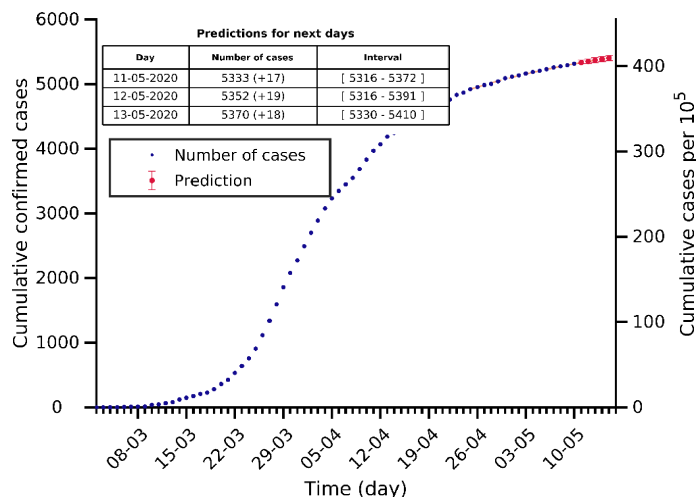
C Valenciana 10-05-2020. Population: 5.0M. Current cumulated incidence: 214/10⁵



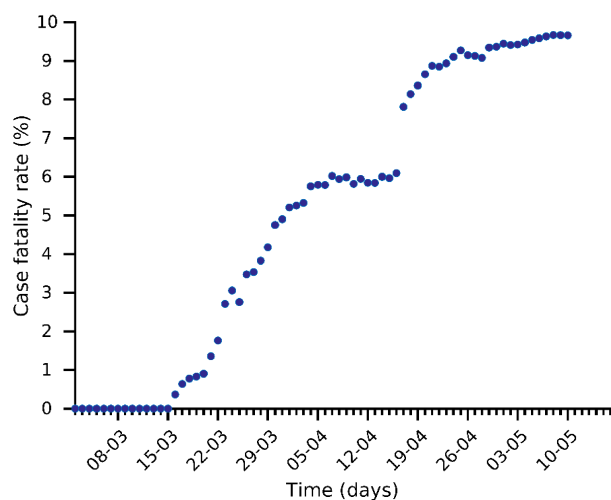
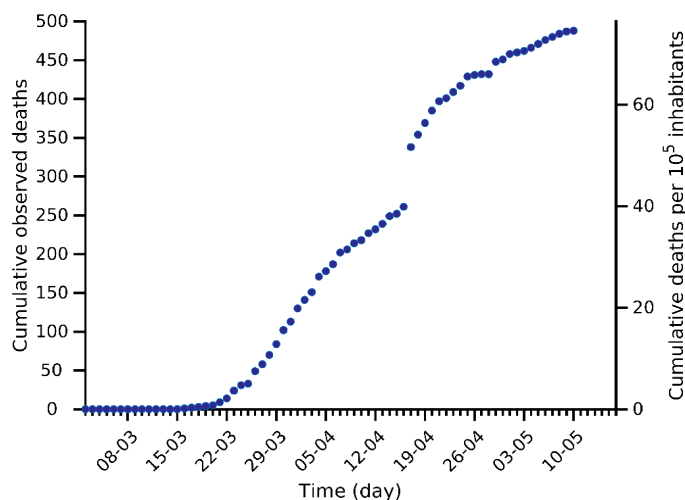
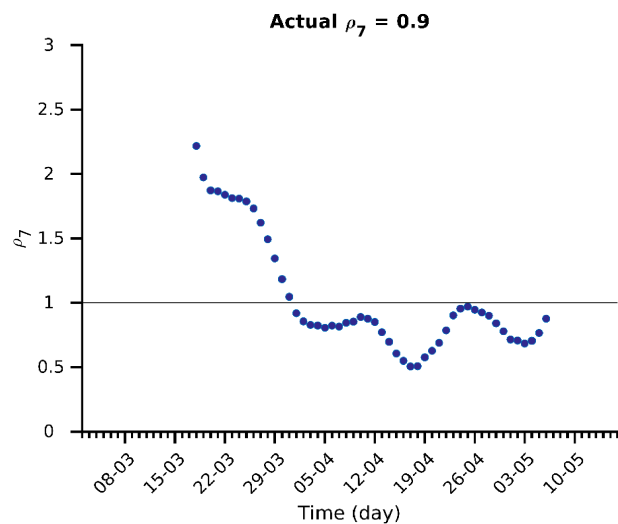
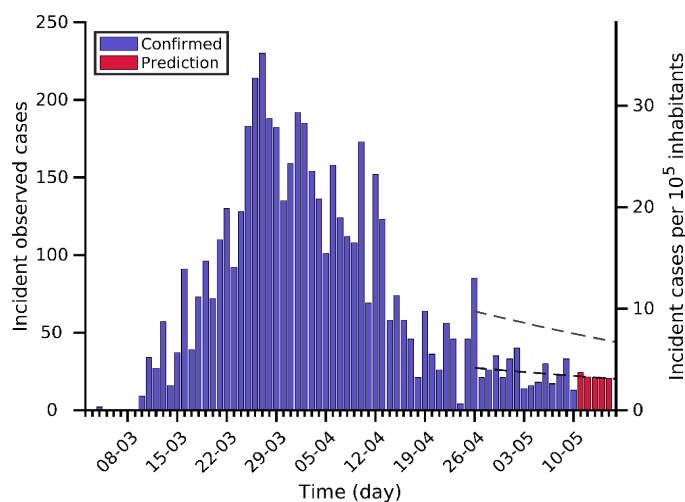
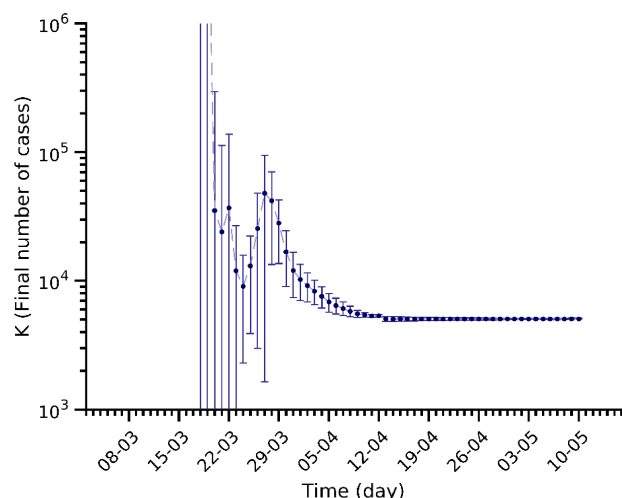
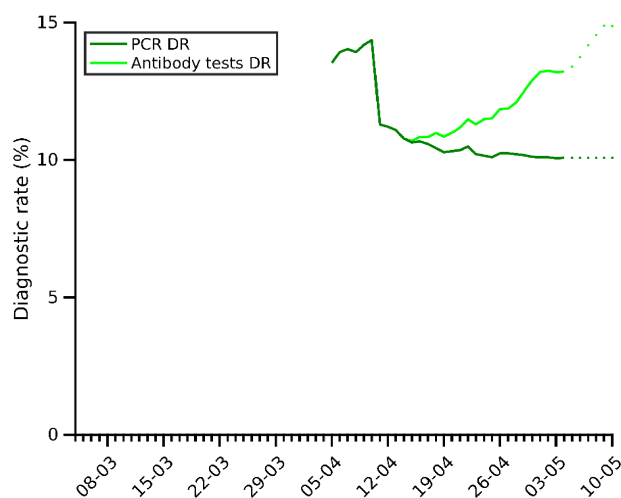
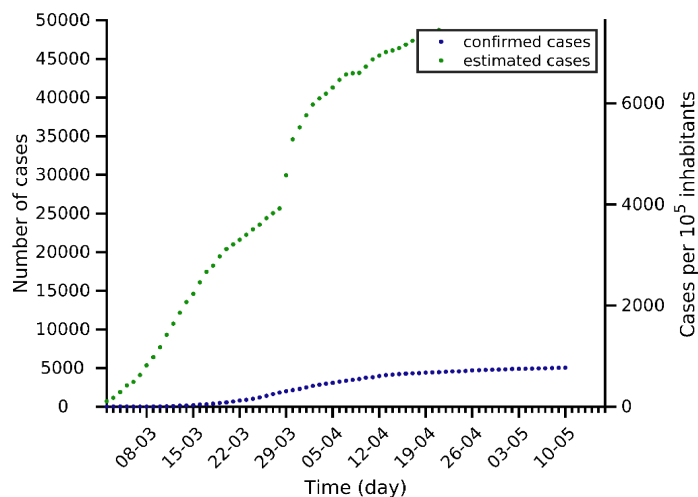
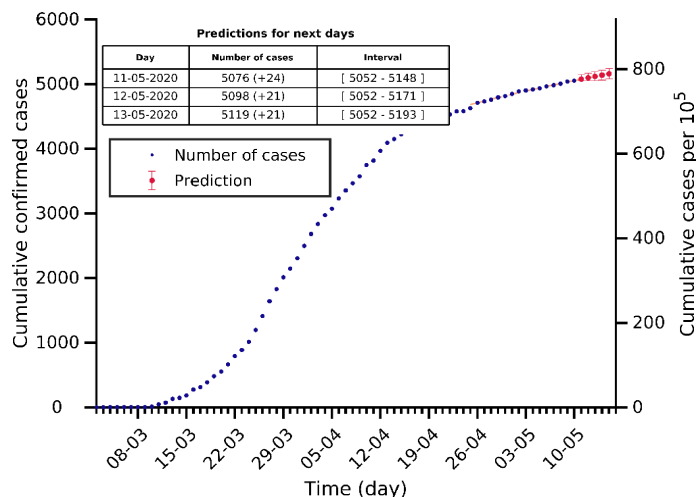
Galicia 10-05-2020. Population: 2.7M. Current cumulated incidence: 343/10⁵



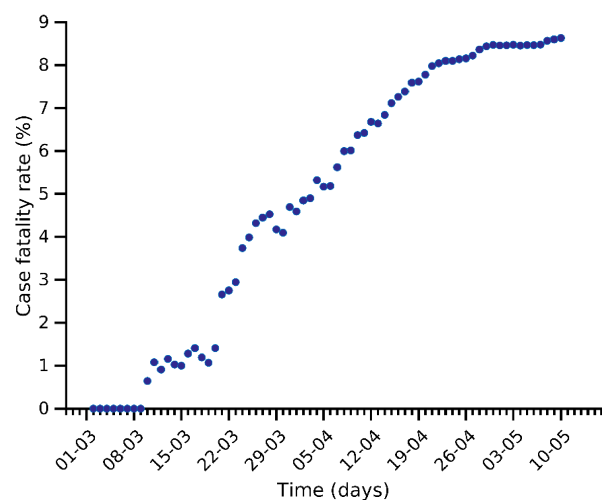
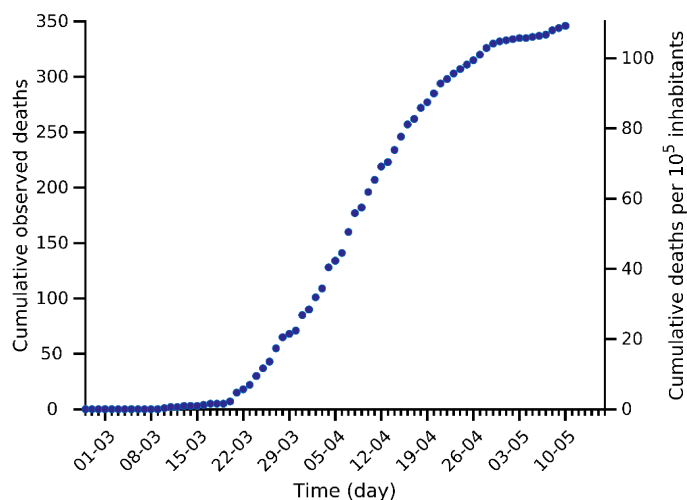
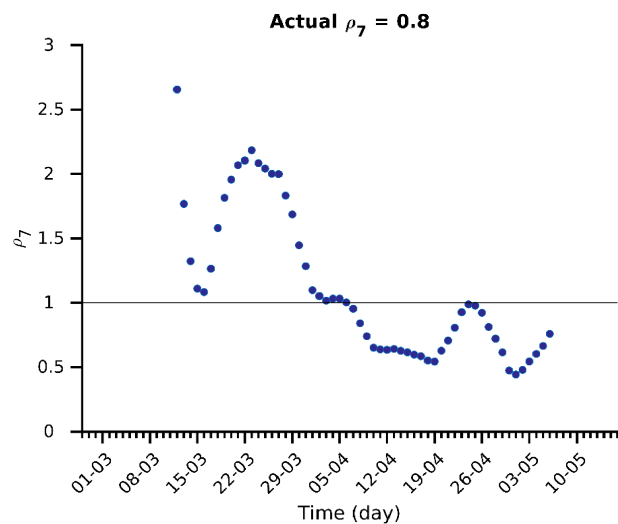
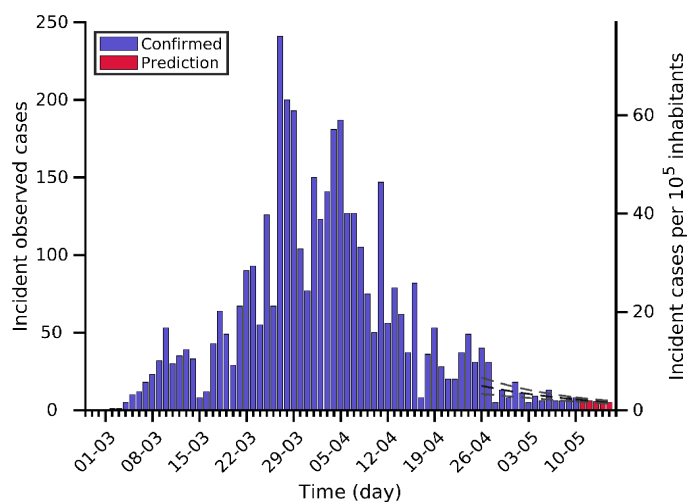
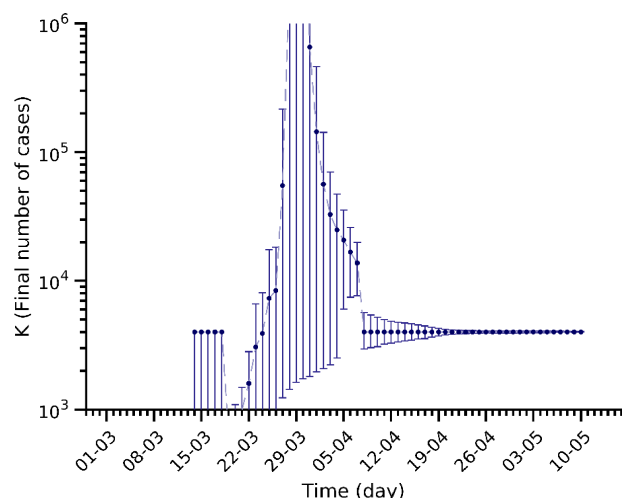
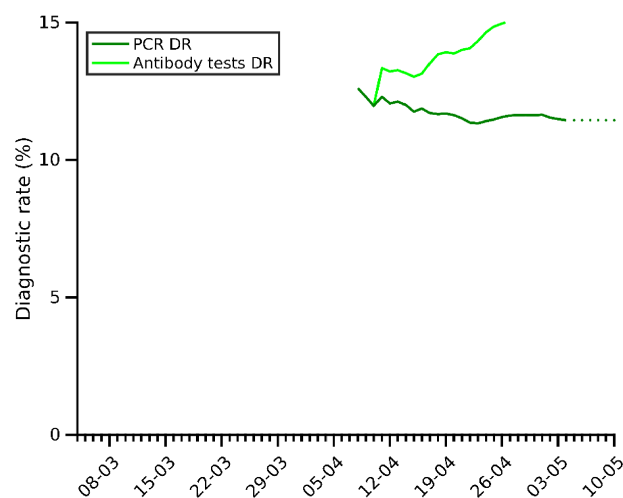
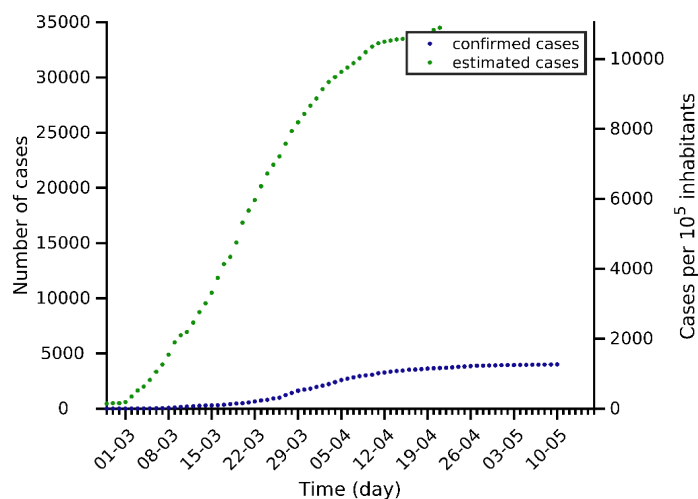
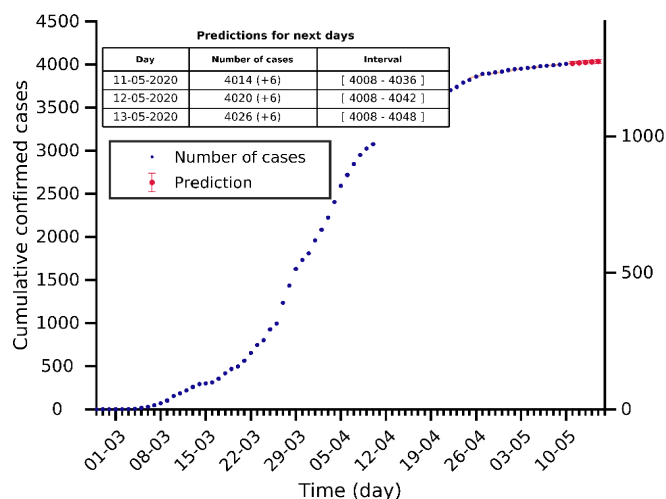
Aragon 10-05-2020. Population: 1.3M. Current cumulated incidence: 403/10⁵



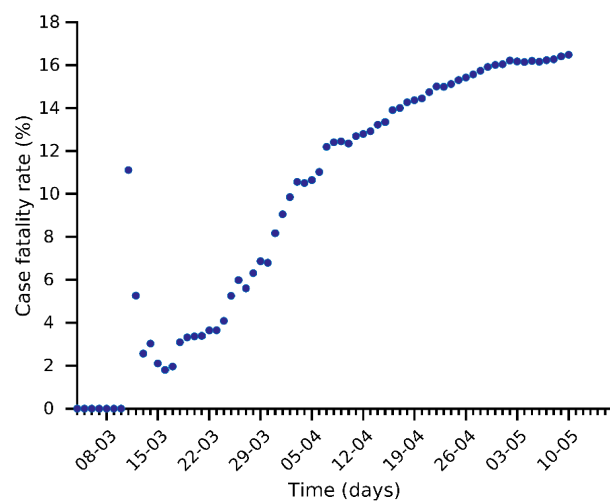
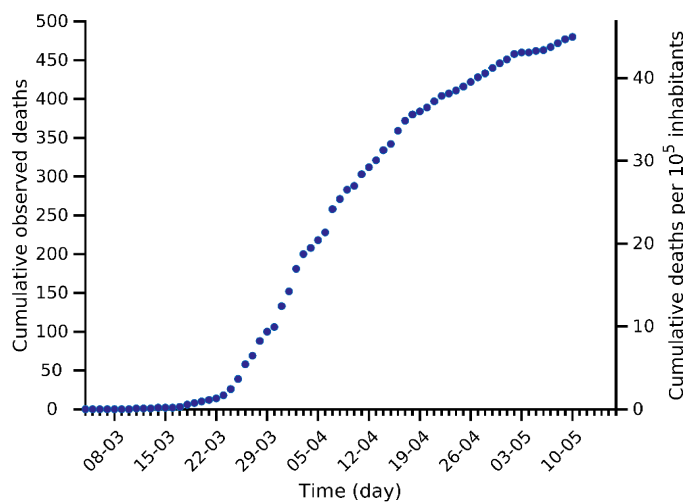
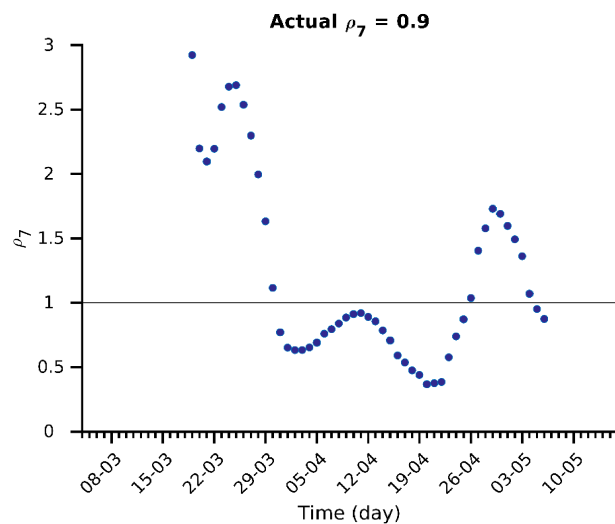
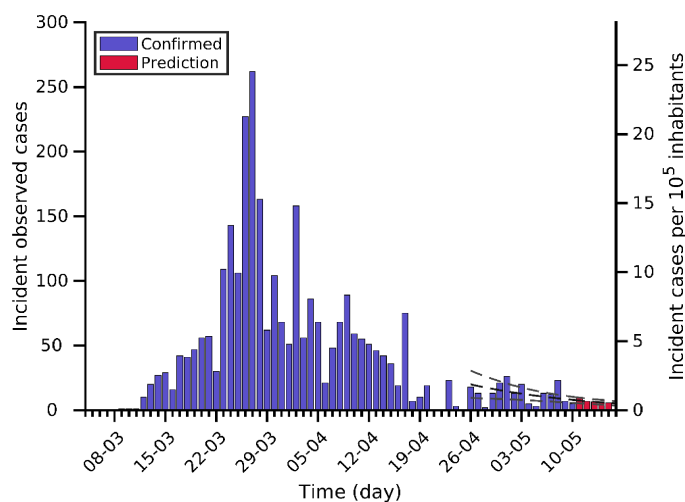
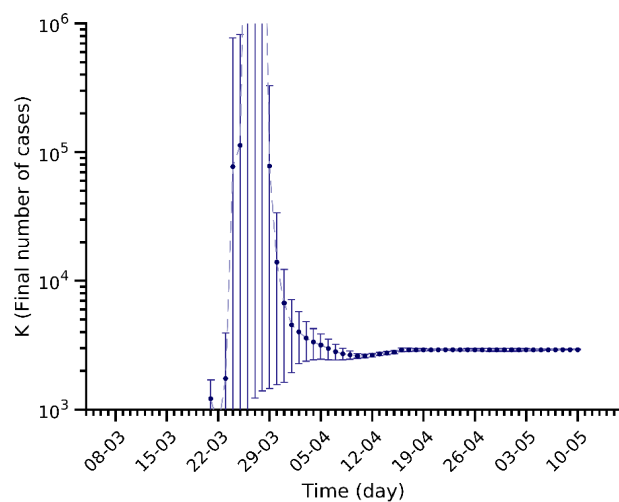
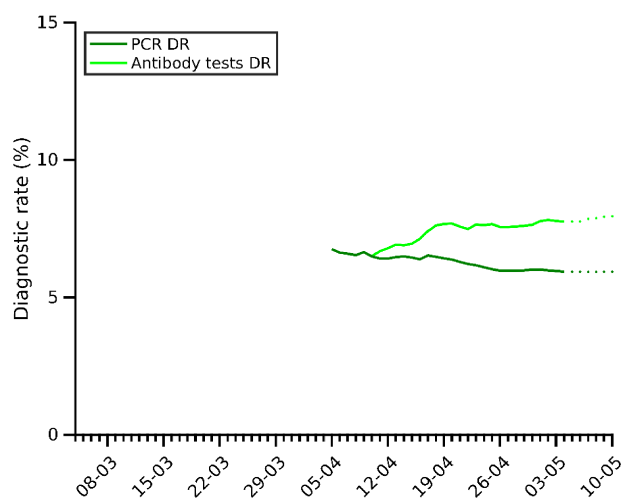
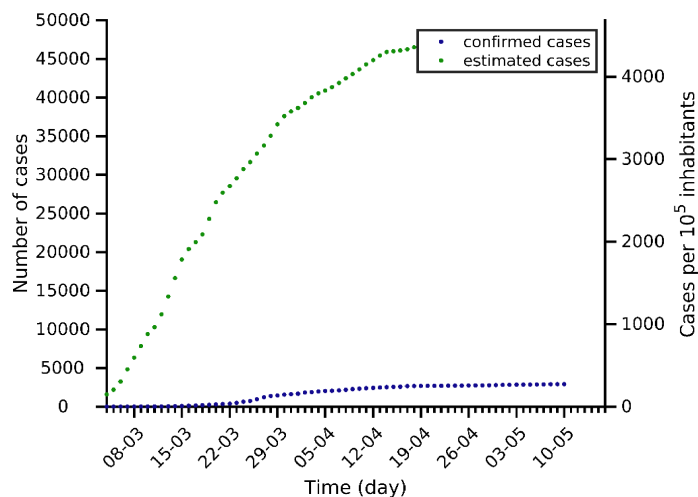
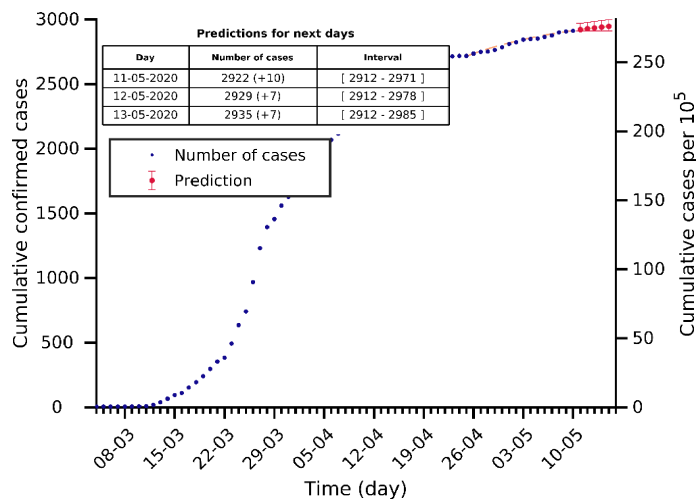
Navarra 10-05-2020. Population: 0.7M. Current cumulated incidence: 772/10⁵



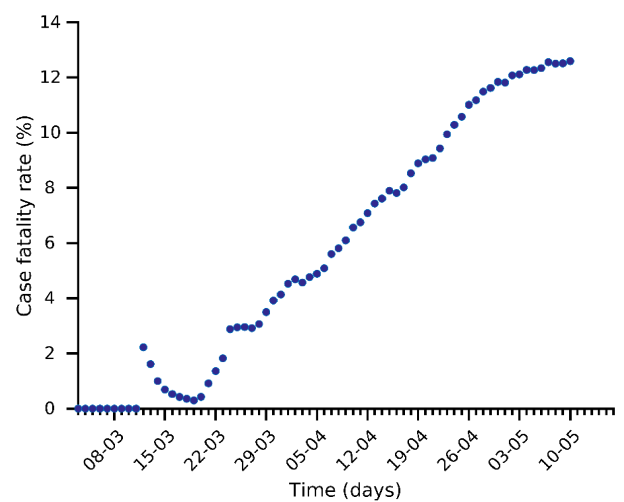
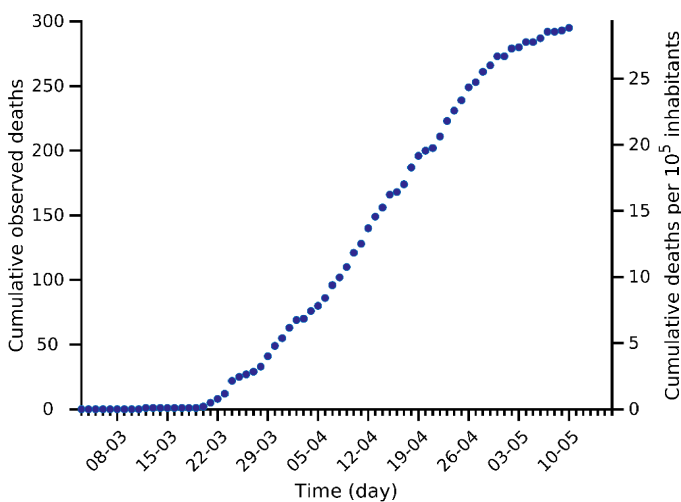
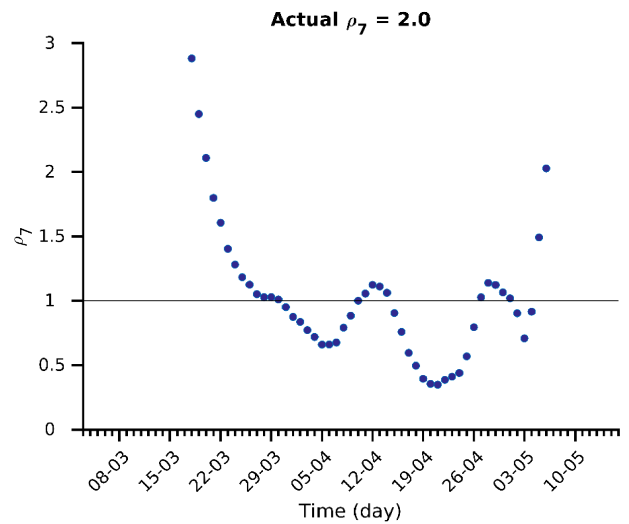
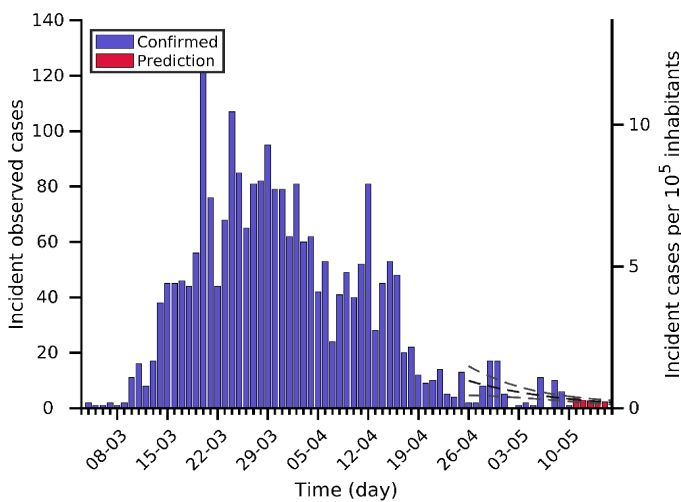
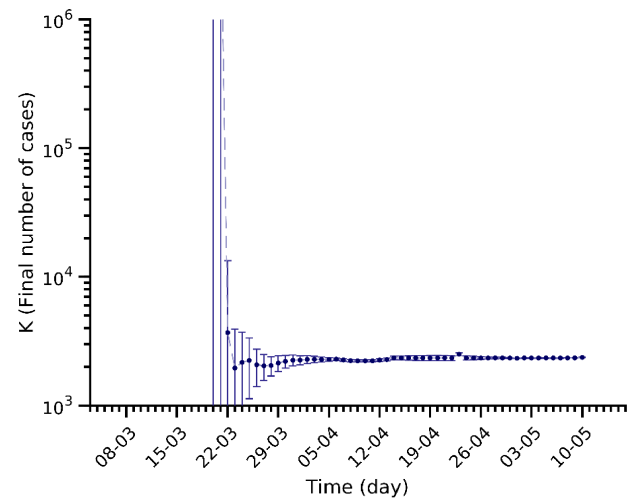
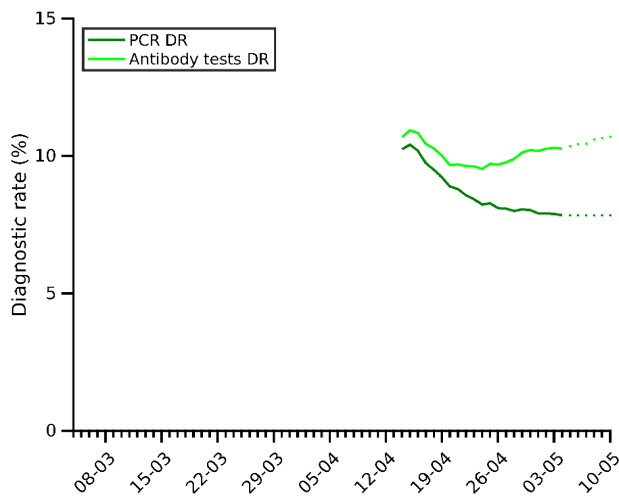
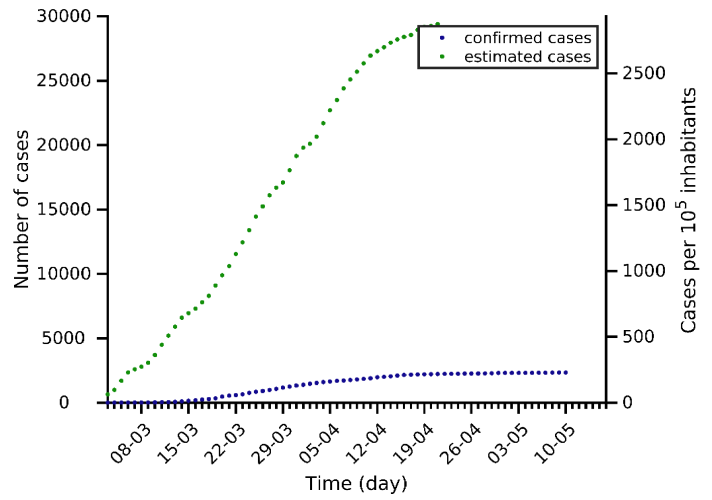
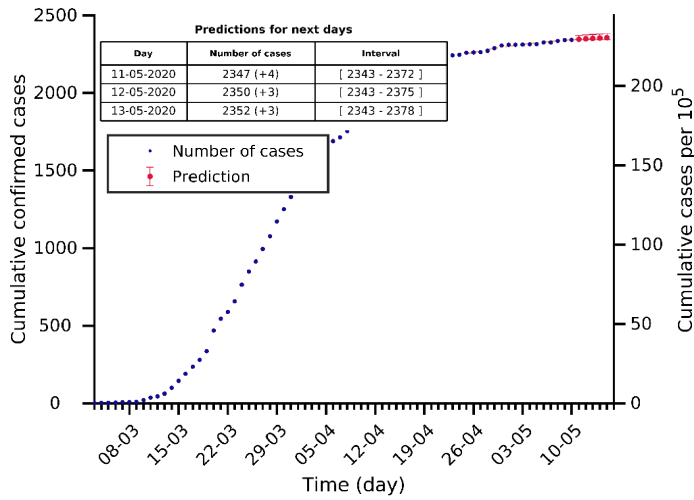
La Rioja 10-05-2020. Population: 0.3M. Current cumulated incidence: 1265/10⁵



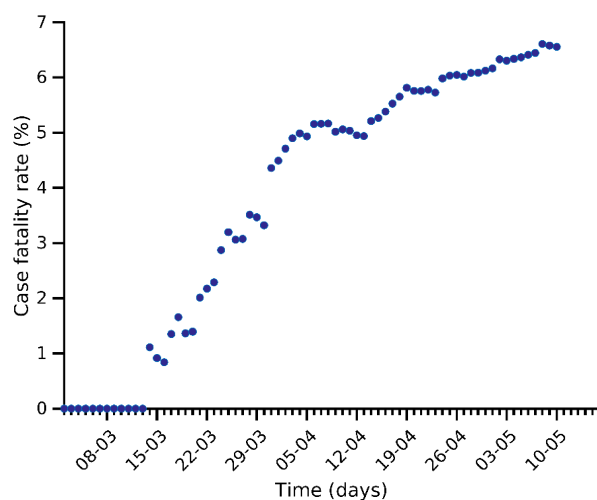
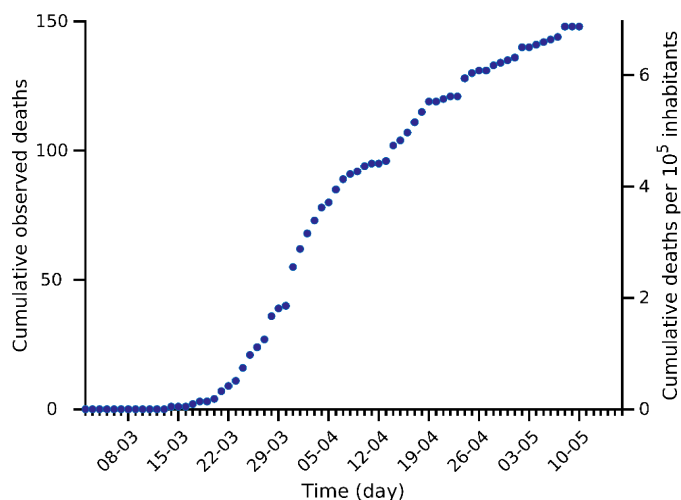
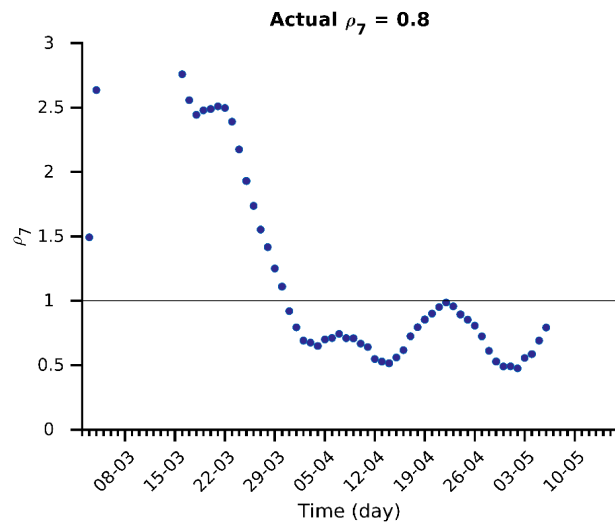
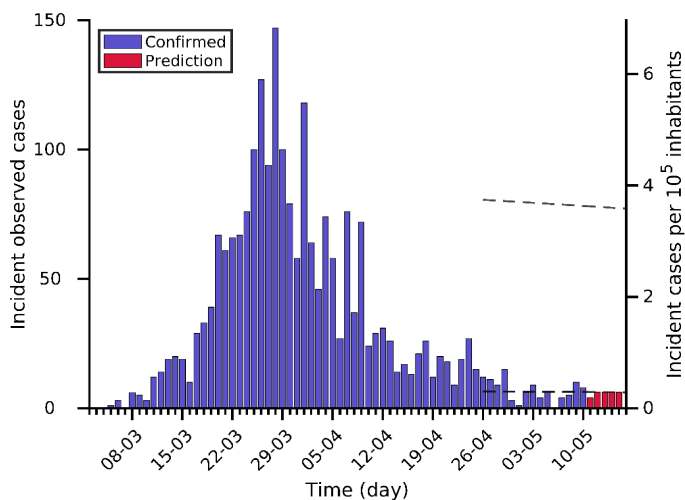
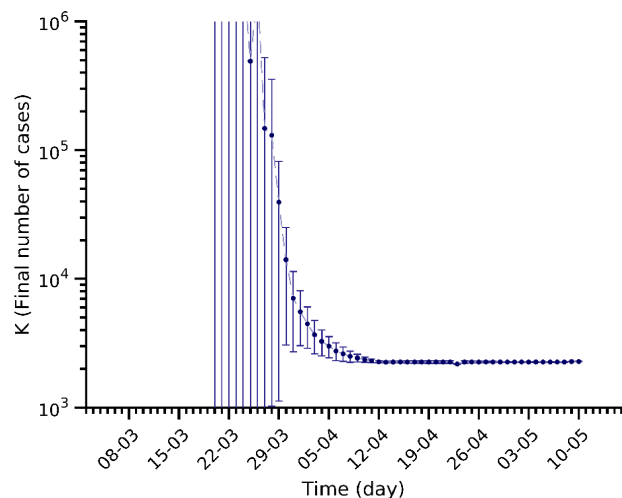
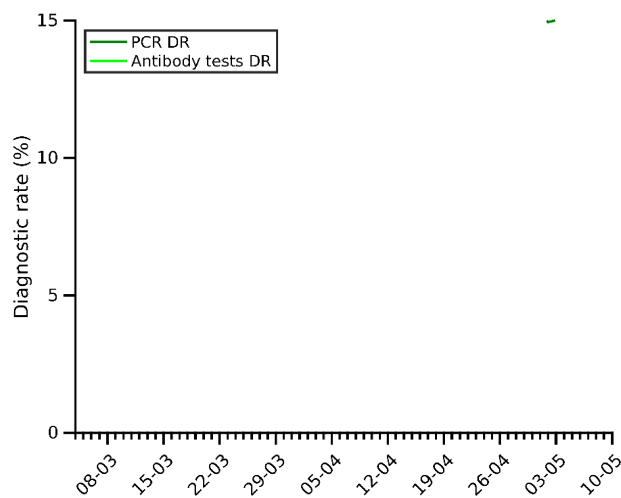
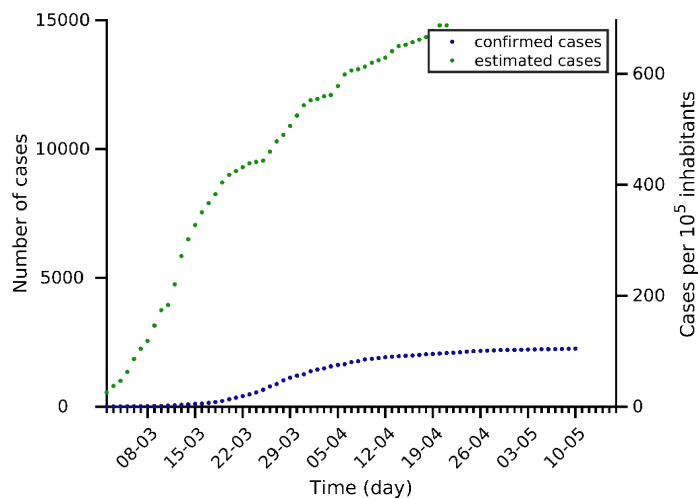
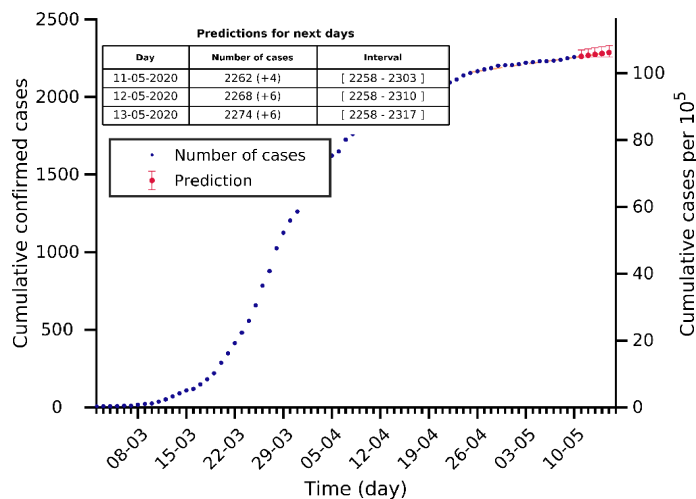
Extremadura 10-05-2020. Population: 1.1M. Current cumulated incidence: 273/10⁵



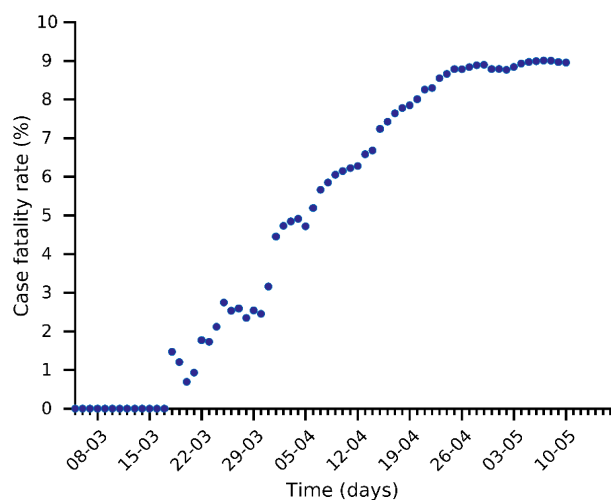
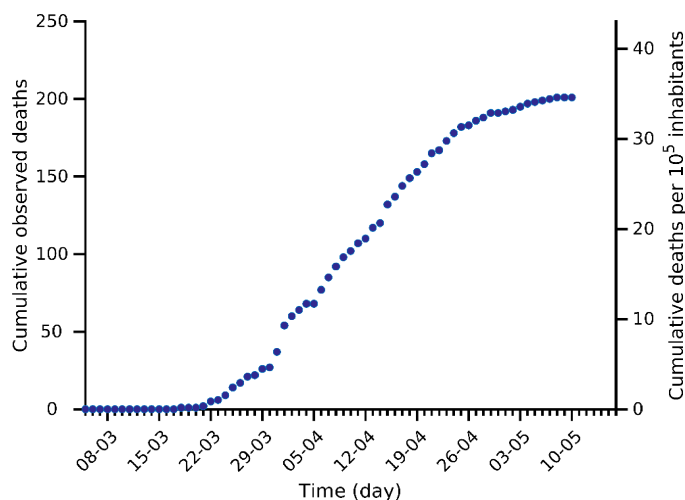
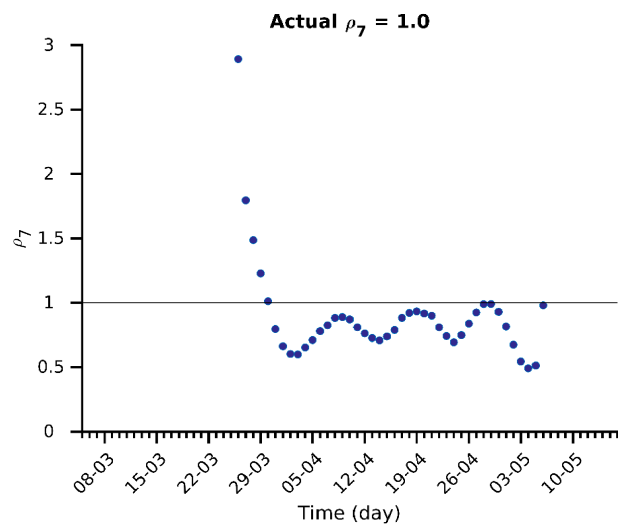
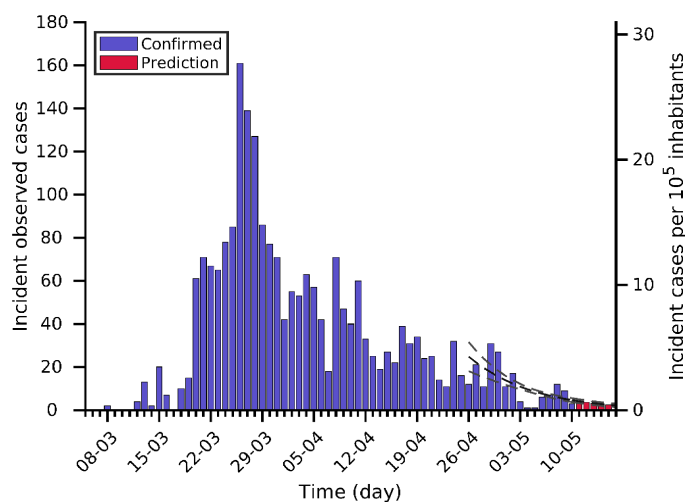
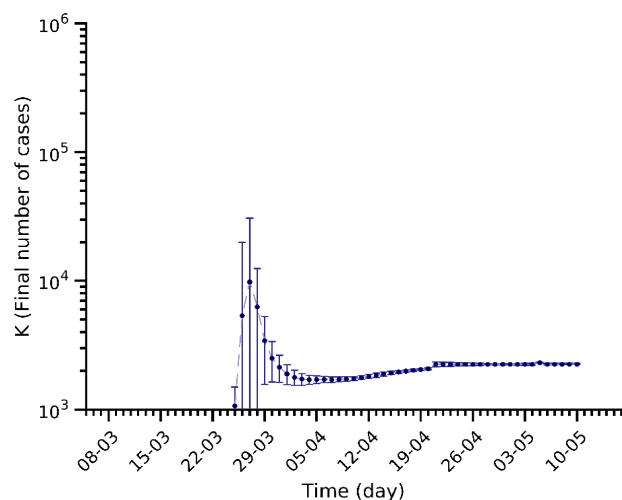
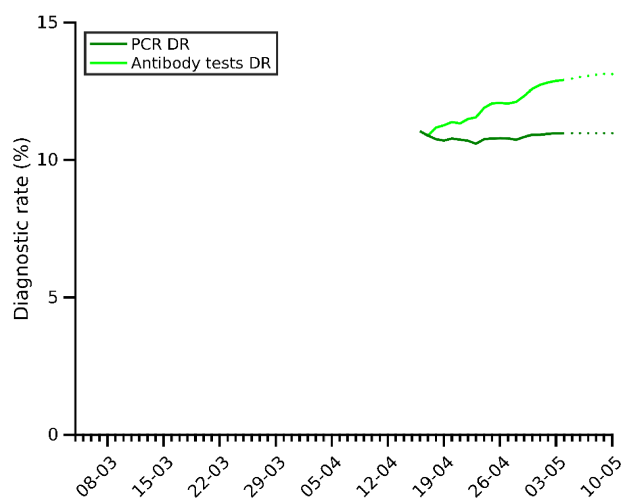
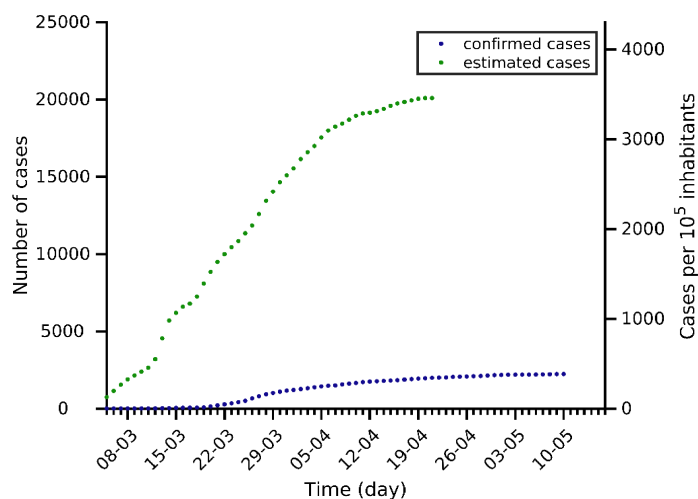
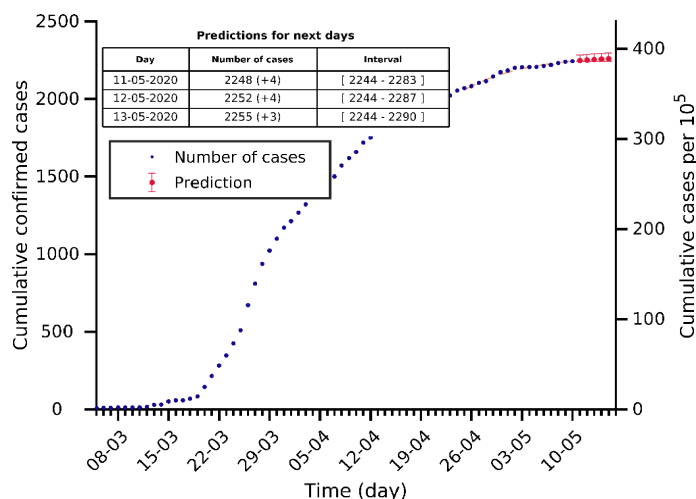
Asturias 10-05-2020. Population: 1.0M. Current cumulated incidence: 229/10⁵



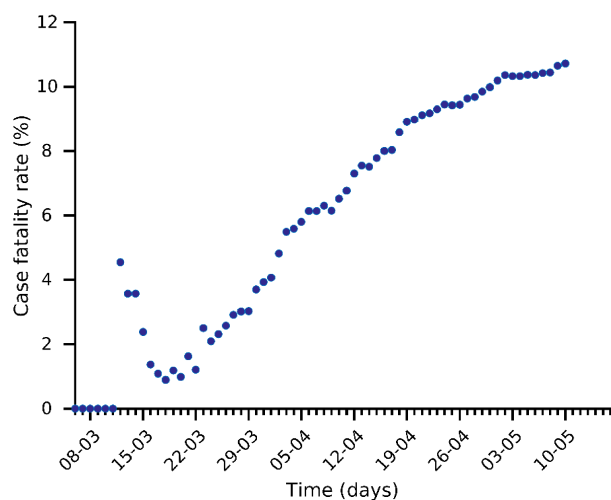
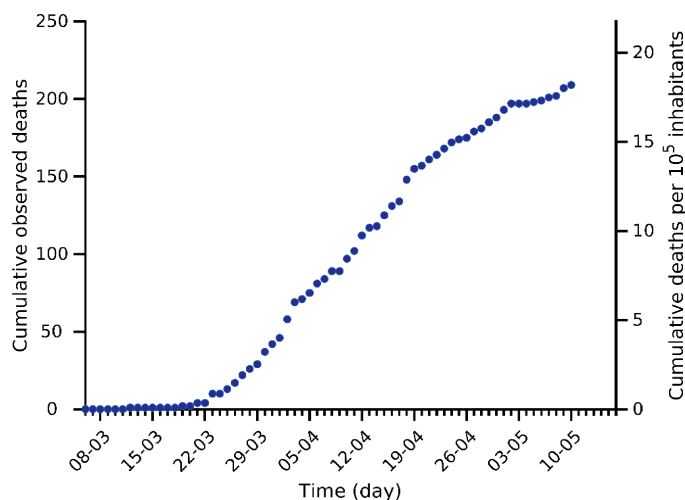
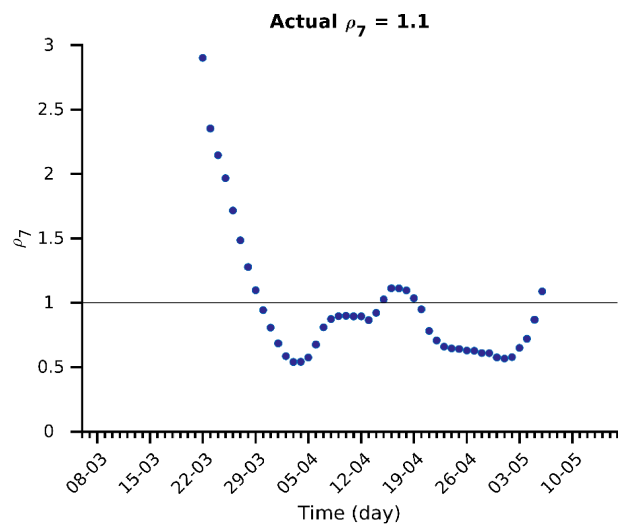
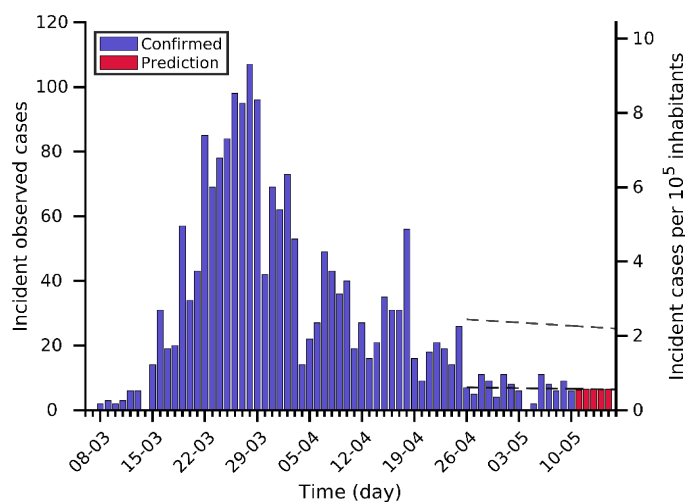
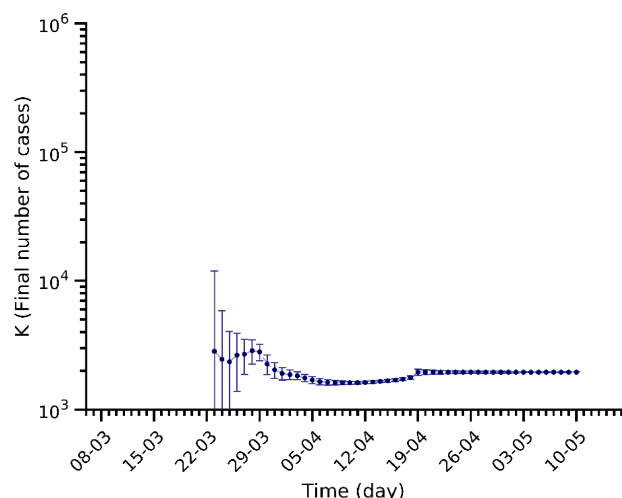
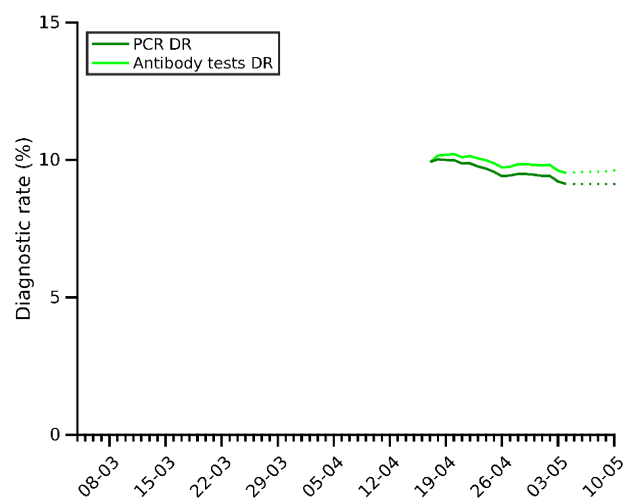
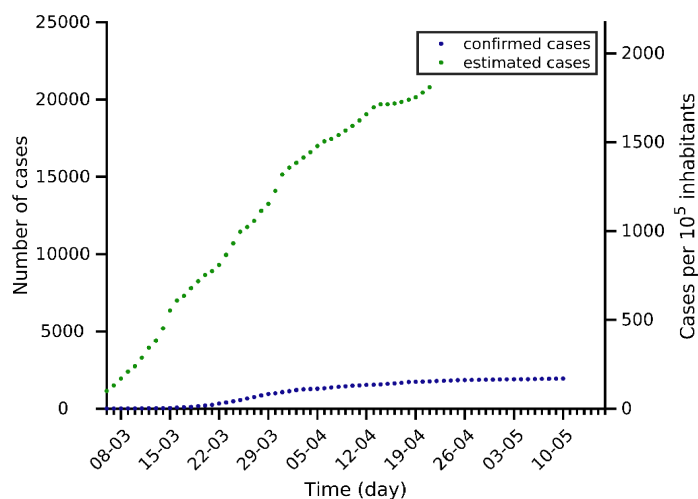
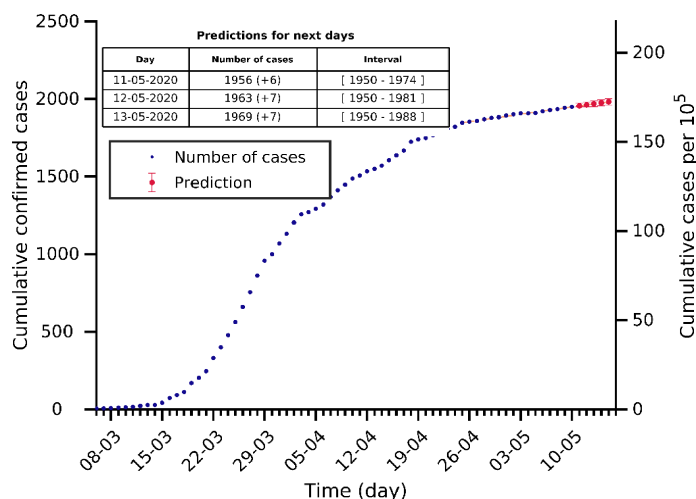
Canarias 10-05-2020. Population: 2.2M. Current cumulated incidence: 105/10⁵



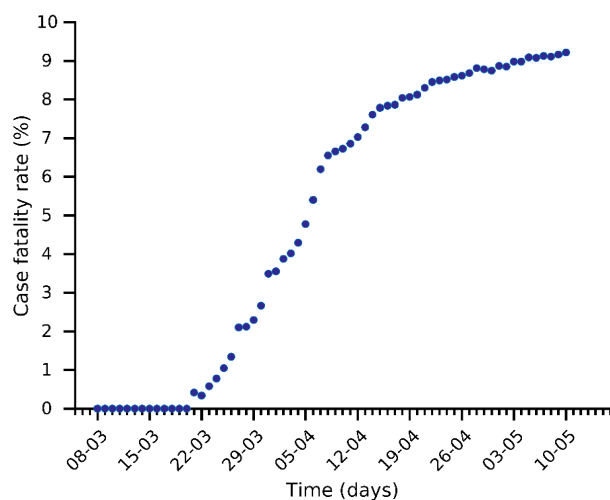
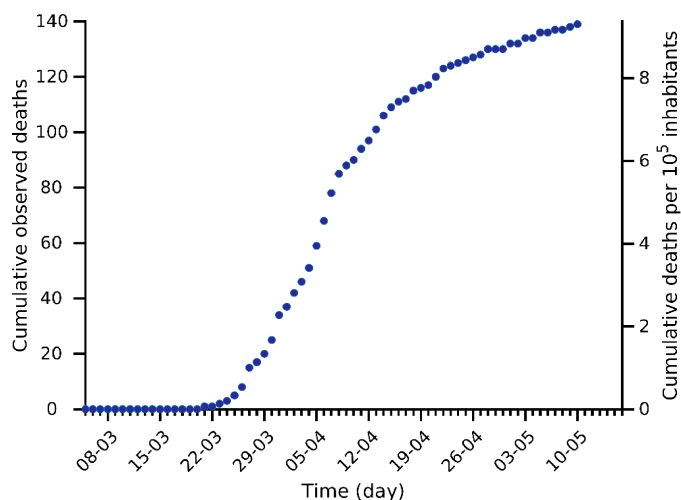
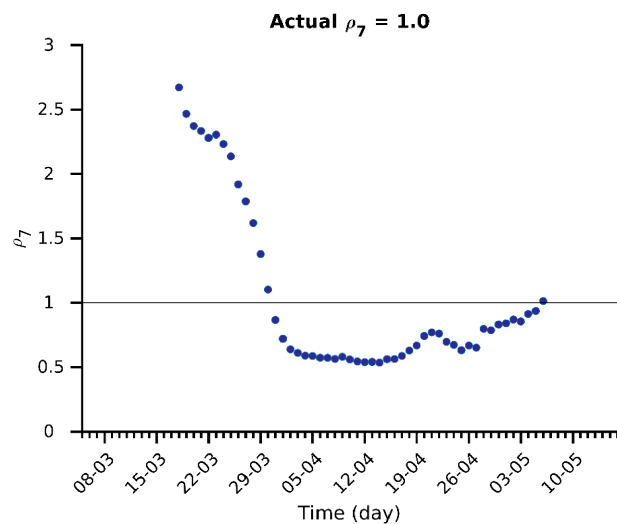
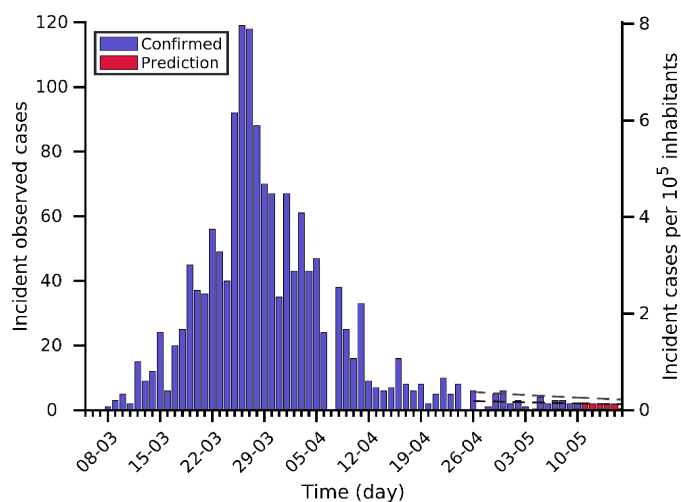
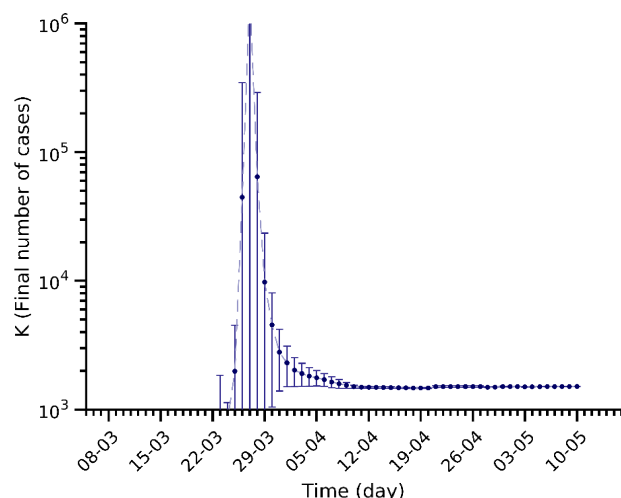
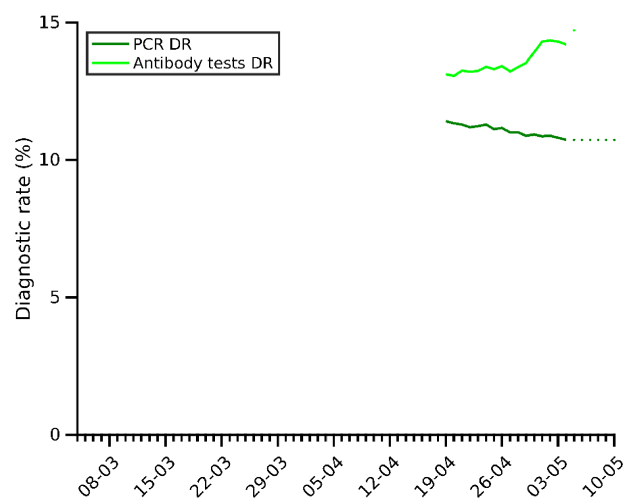
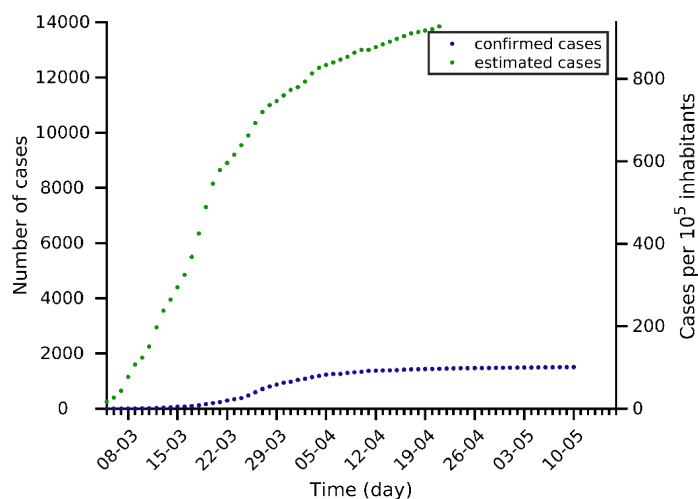
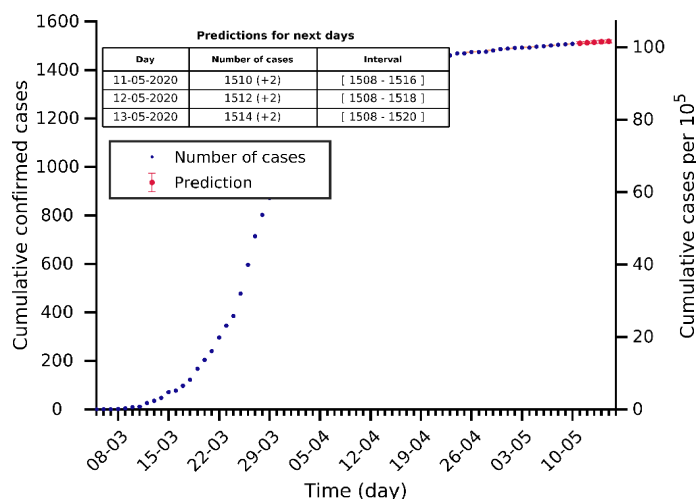
Cantabria 10-05-2020. Population: 0.6M. Current cumulated incidence: 386/10⁵



Baleares 10-05-2020. Population: 1.1M. Current cumulated incidence: 170/10⁵



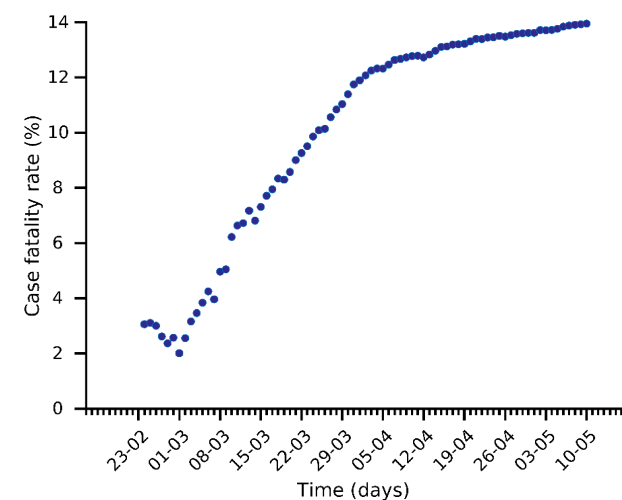
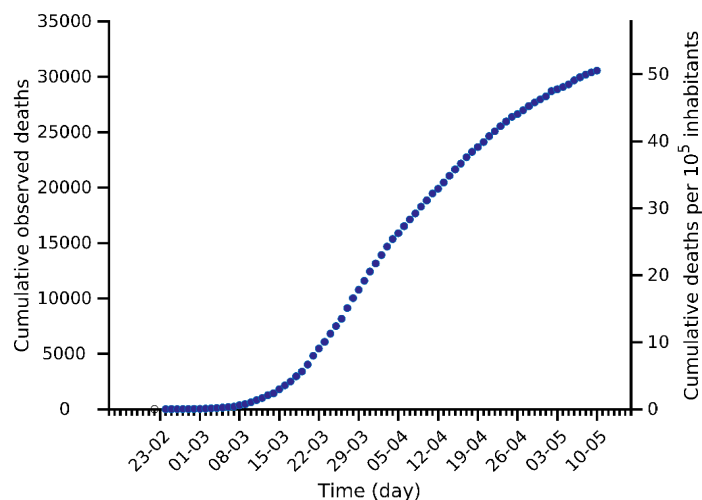
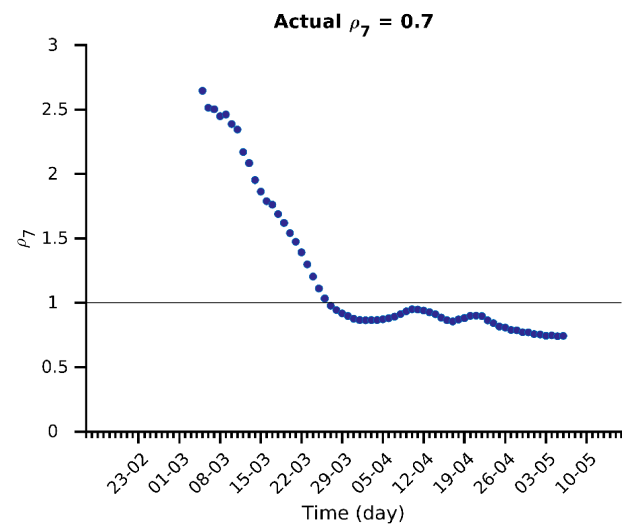
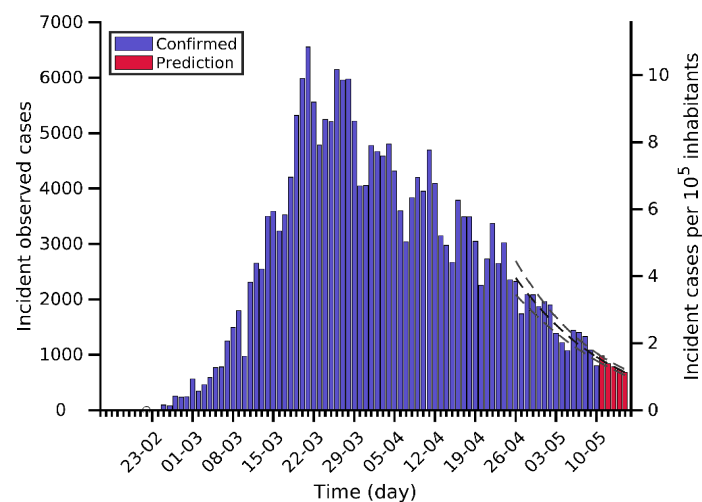
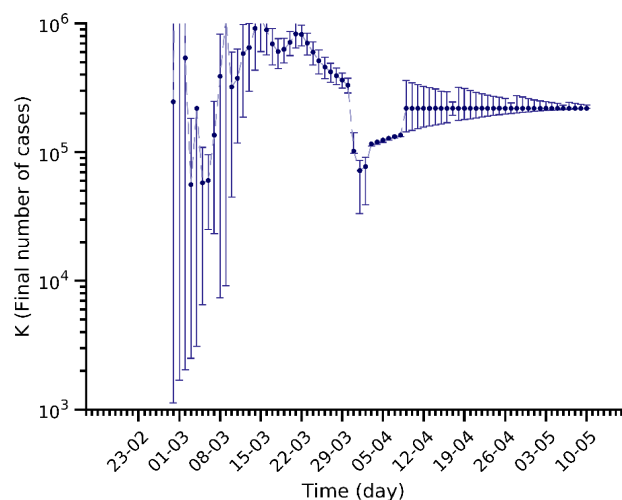
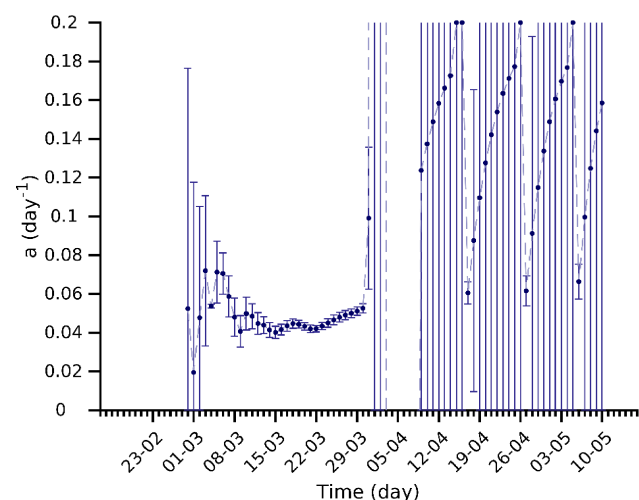
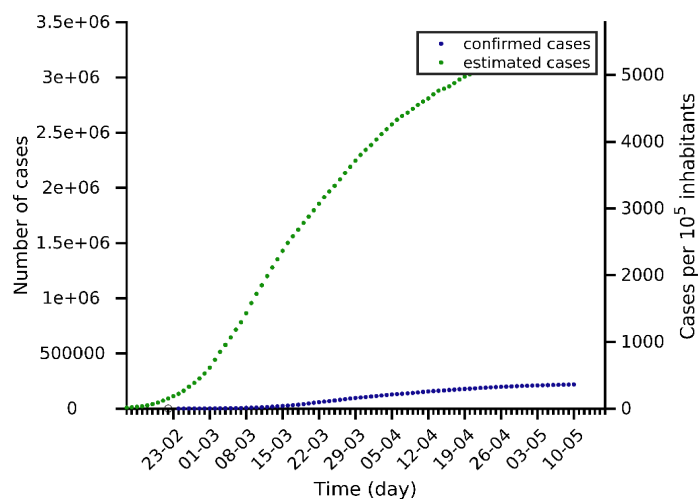
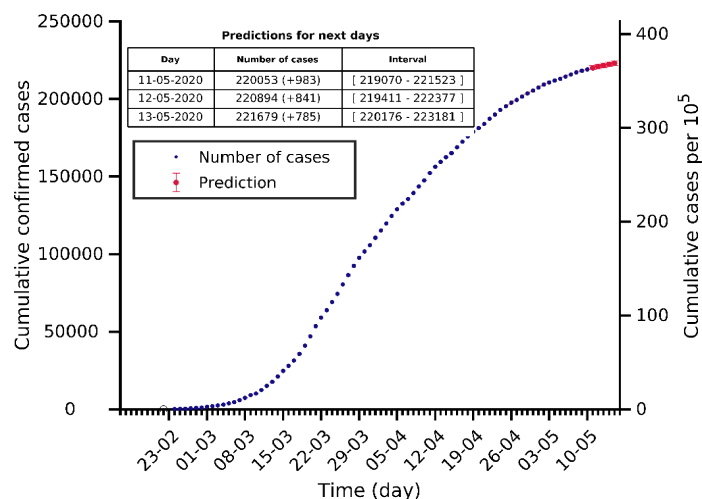
Murcia 10-05-2020. Population: 1.5M. Current cumulated incidence: 101/10⁵



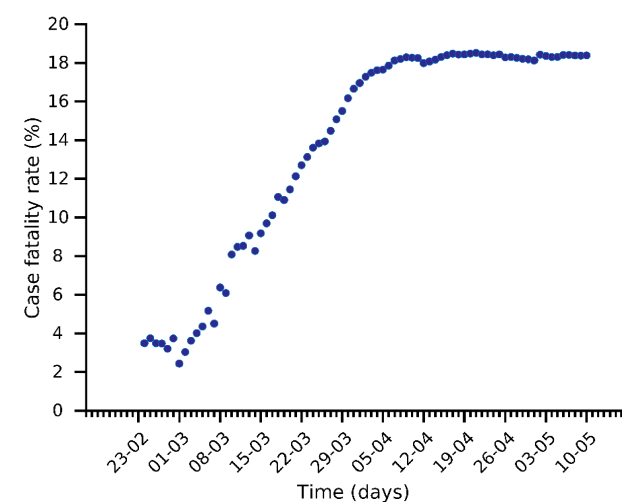
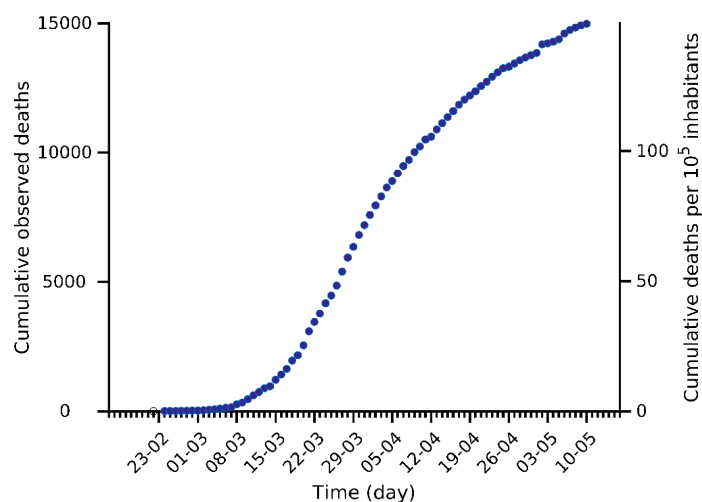
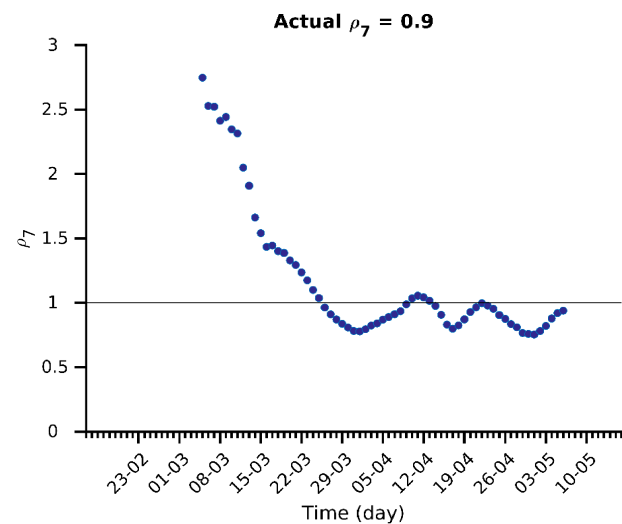
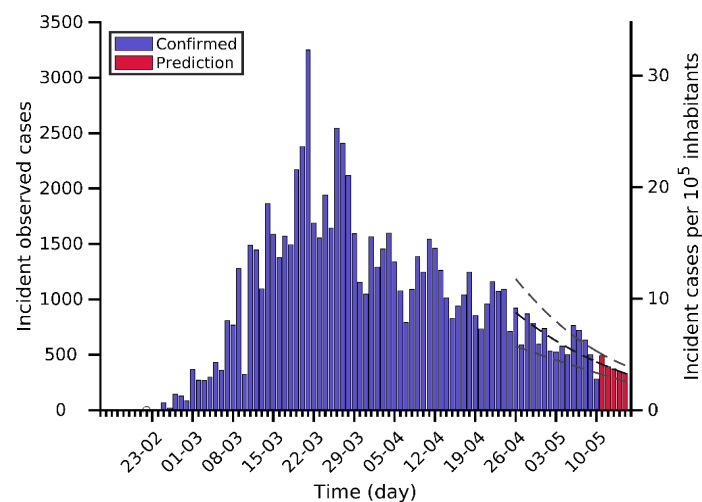
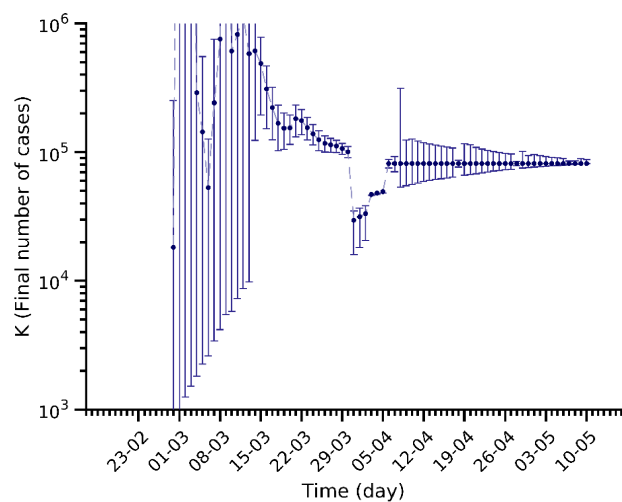
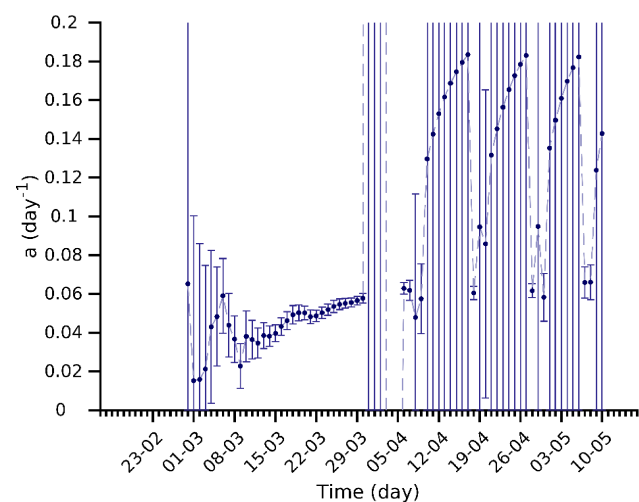
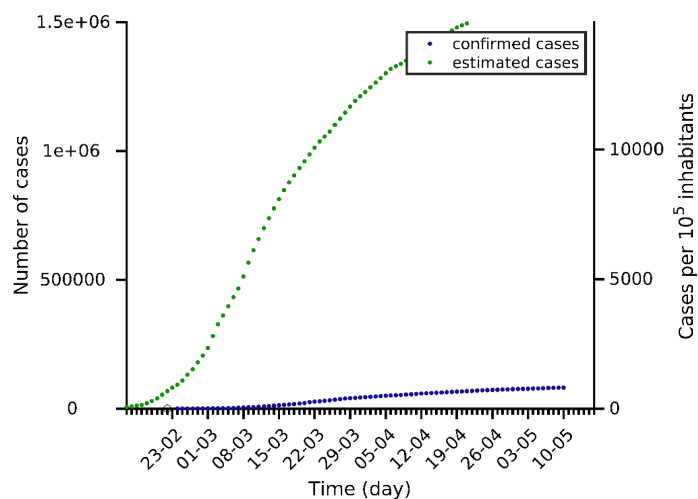
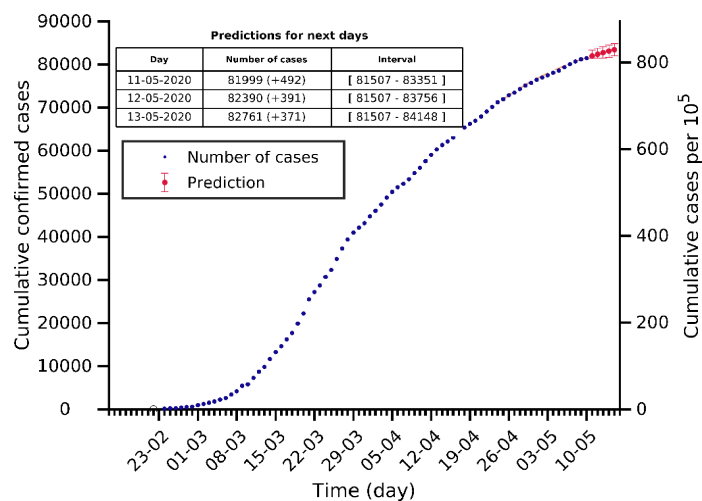
(4) Analysis and prediction of COVID-19 for Italy and its regions

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

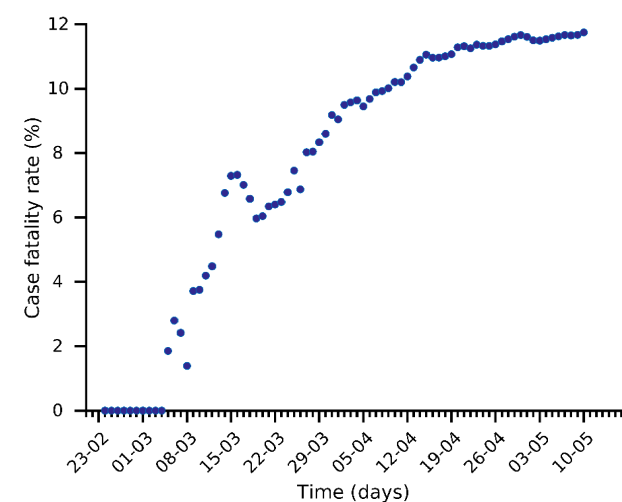
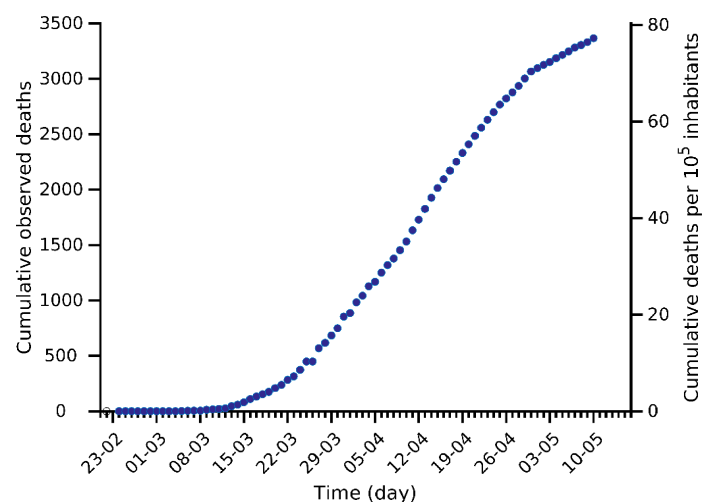
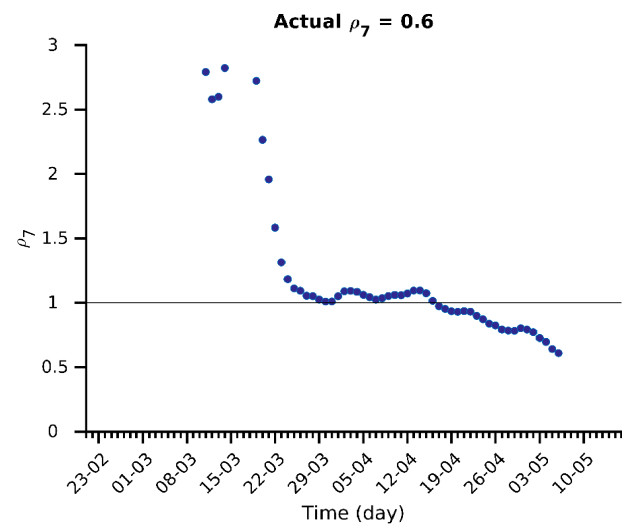
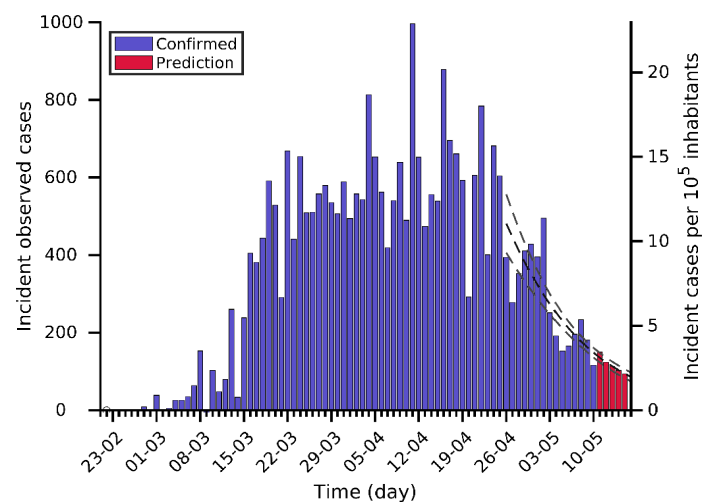
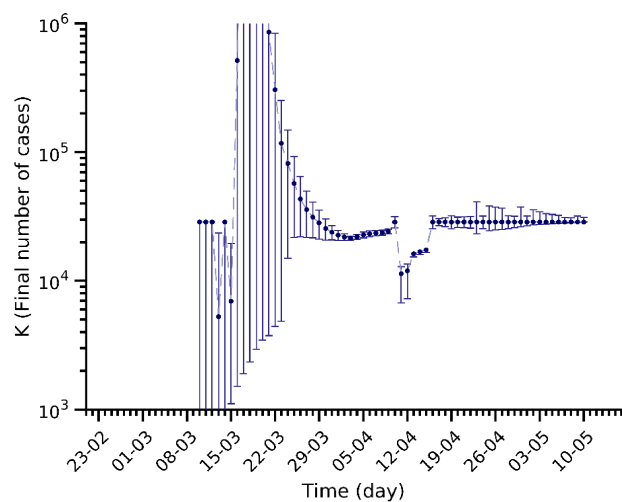
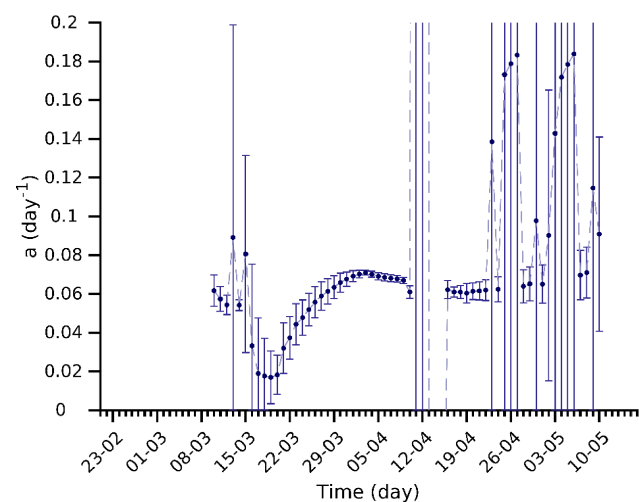
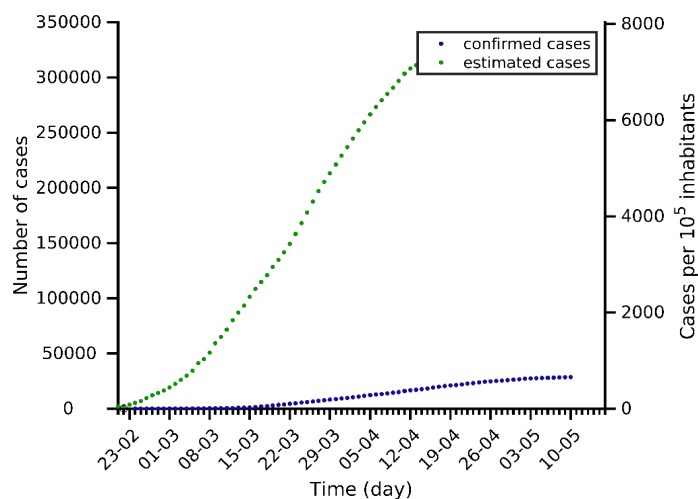
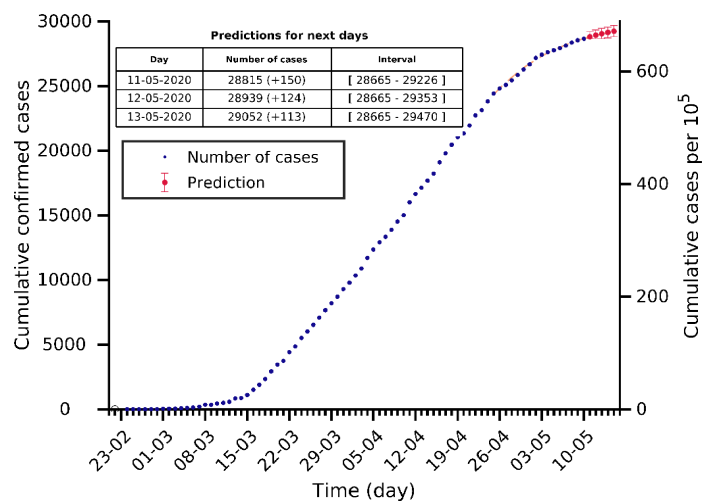
Italy 10-05-2020. Population: 60.5M. Current cumulated incidence: 362/10⁵



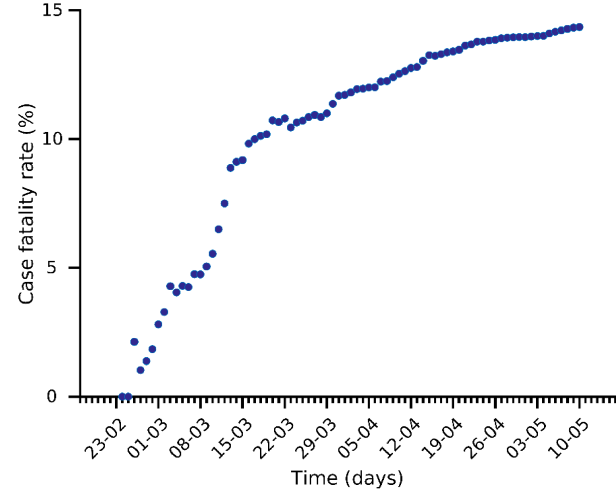
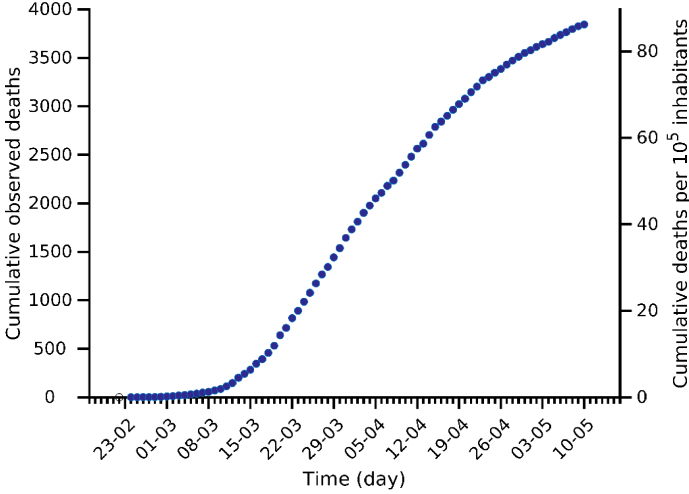
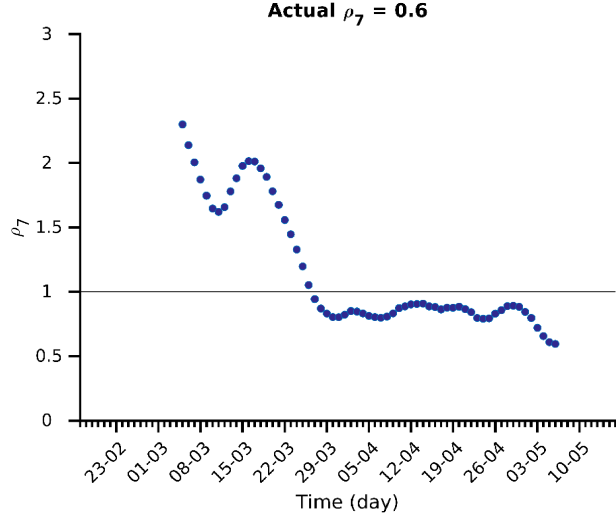
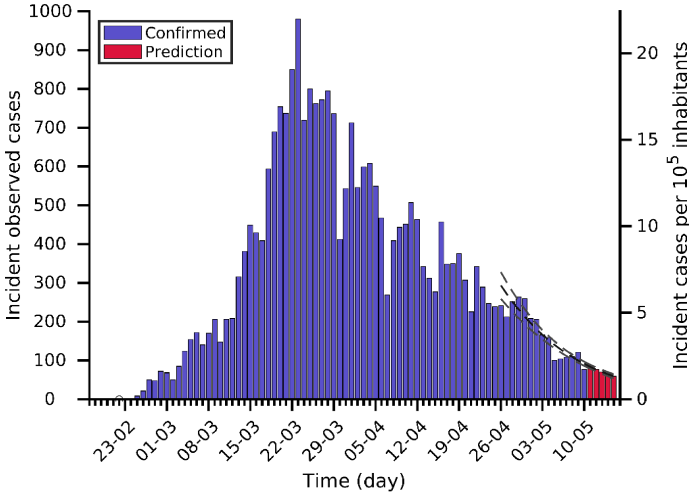
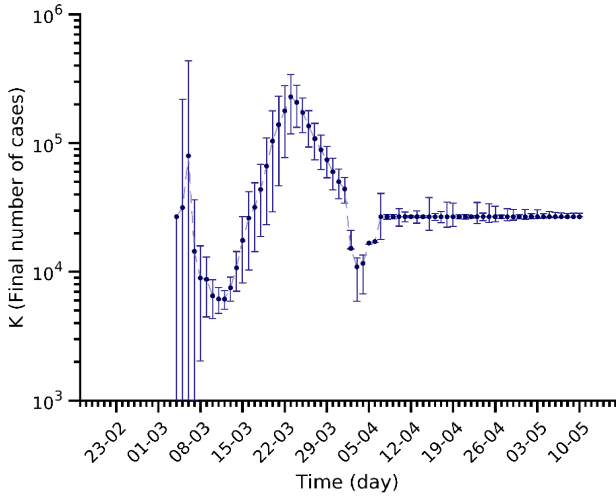
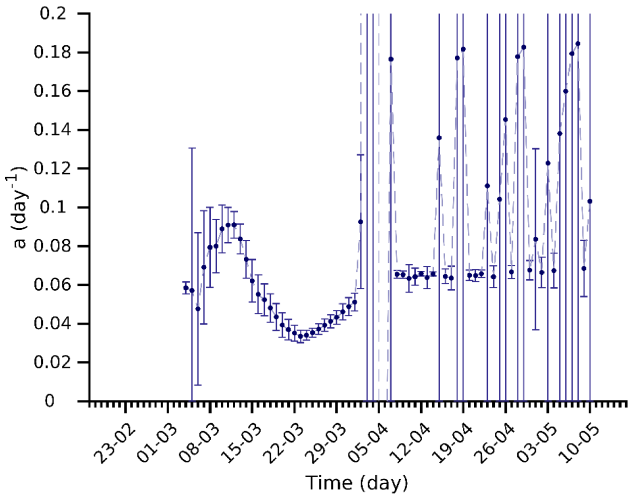
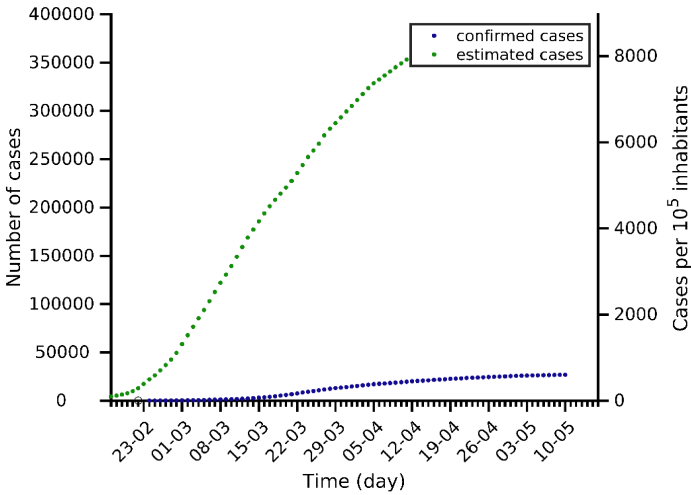
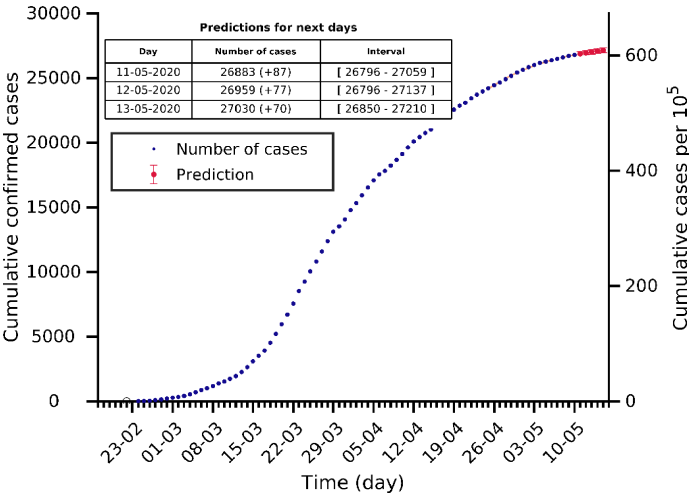
Lombardia 10-05-2020. Population: 10.1M. Current cumulated incidence: 810/10⁵



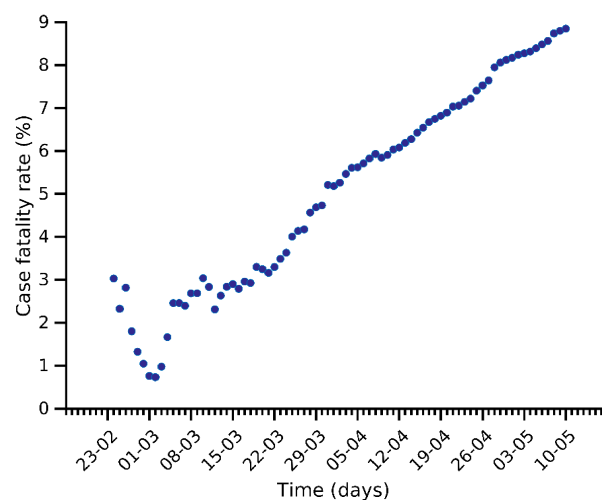
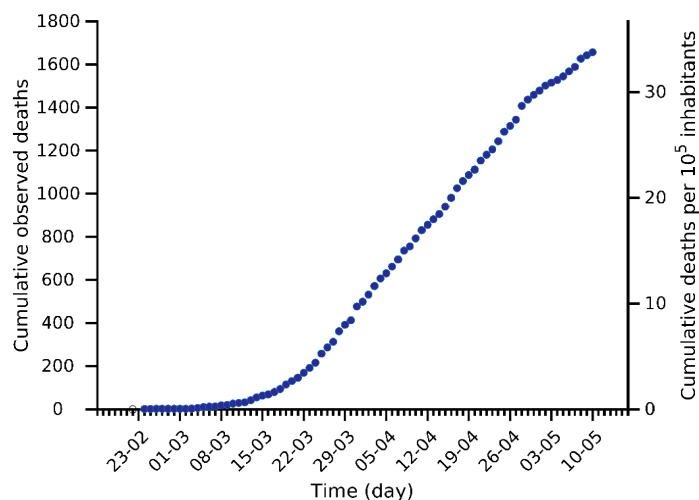
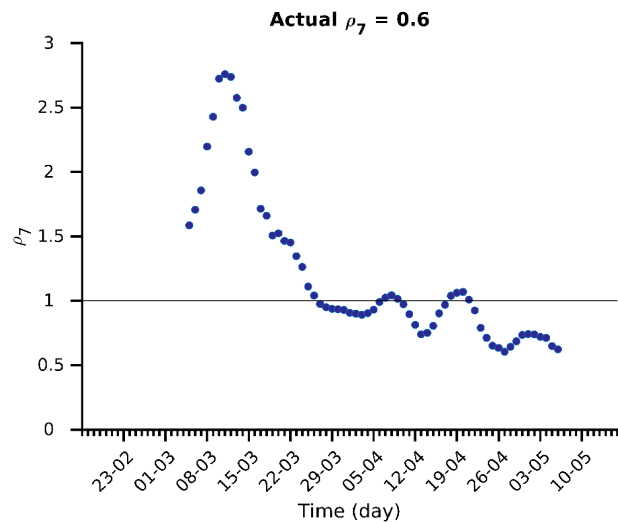
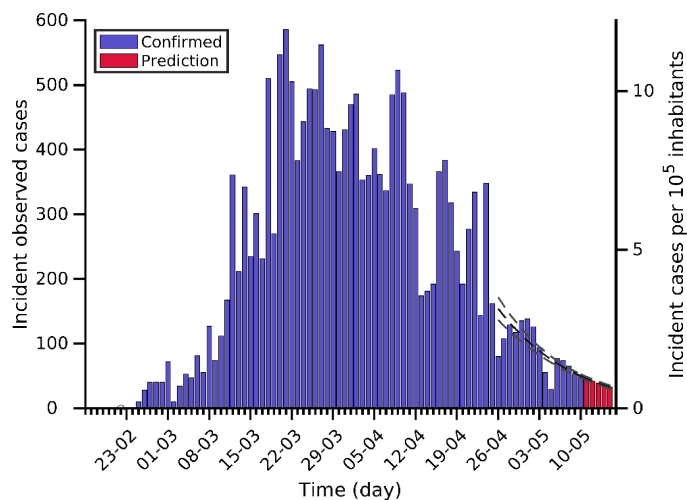
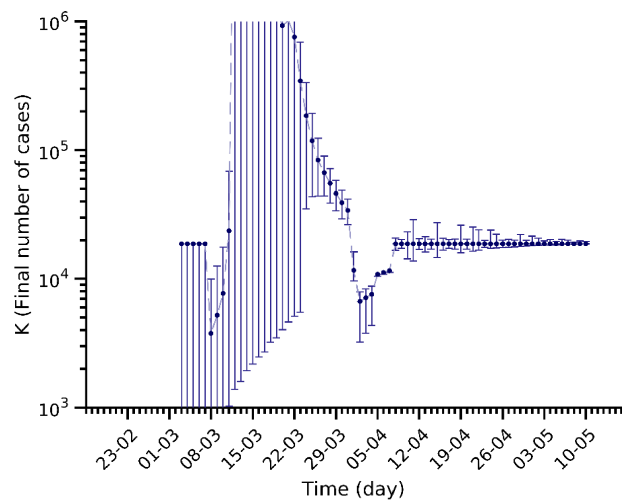
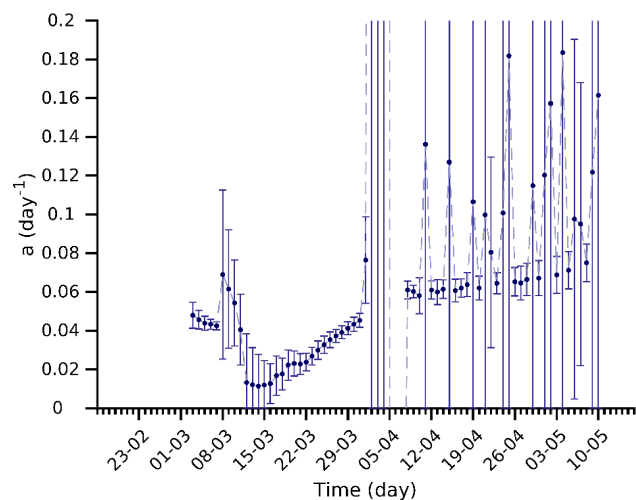
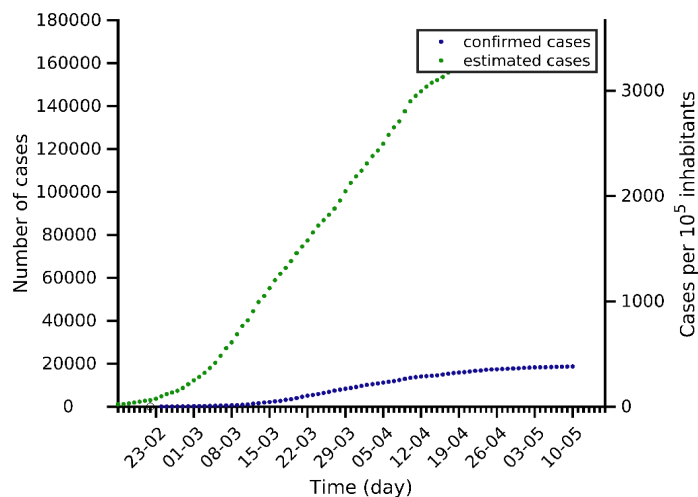
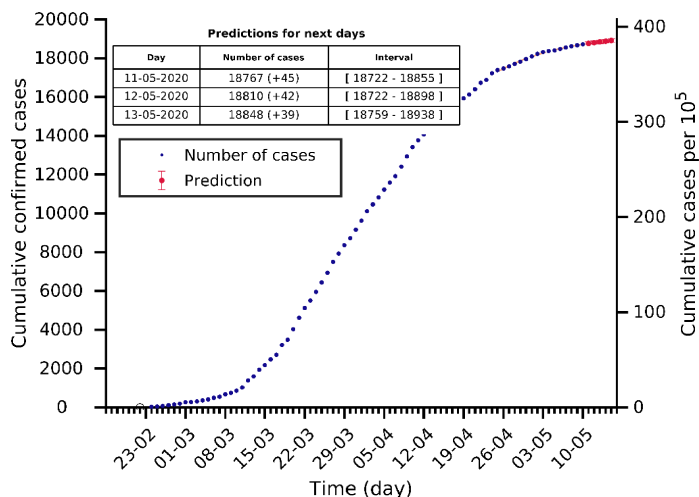
Piemonte 10-05-2020. Population: 4.4M. Current cumulated incidence: 658/10⁵



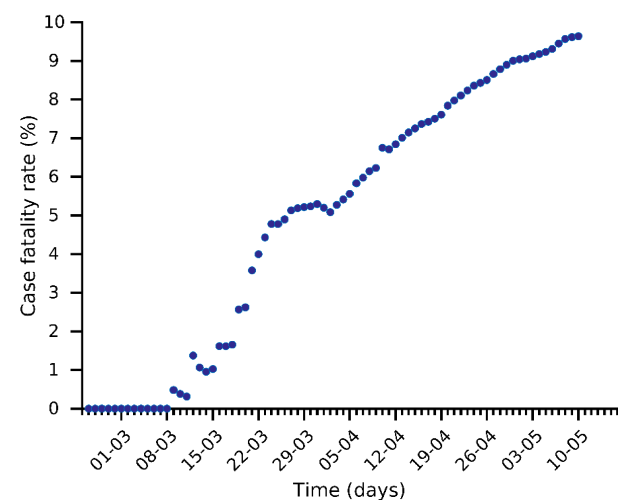
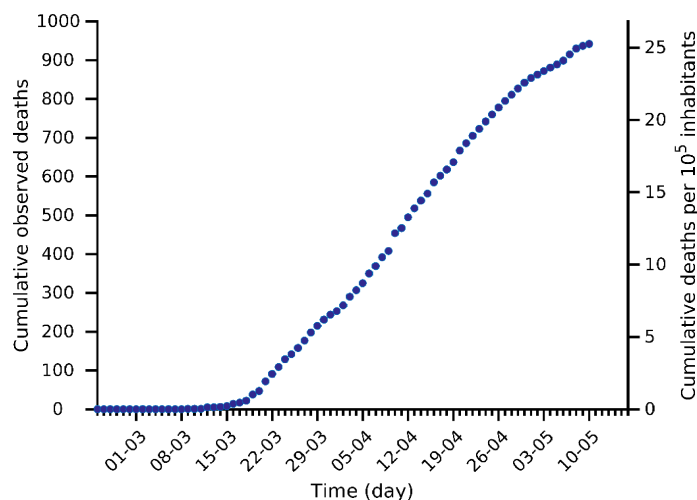
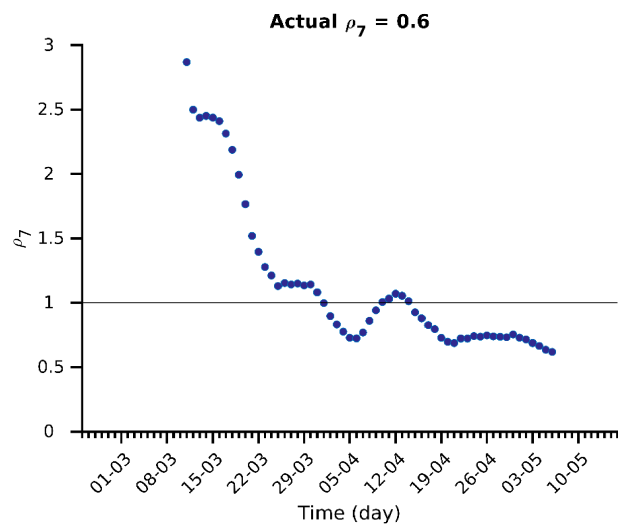
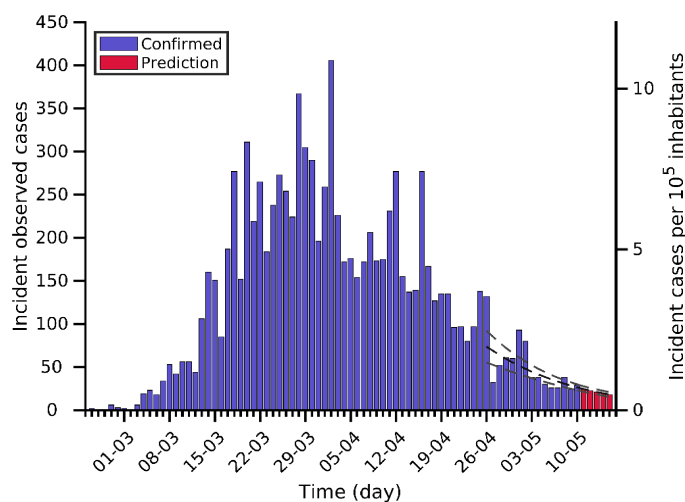
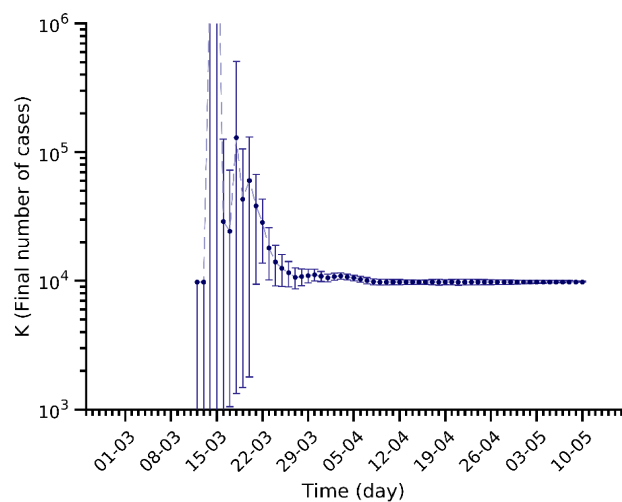
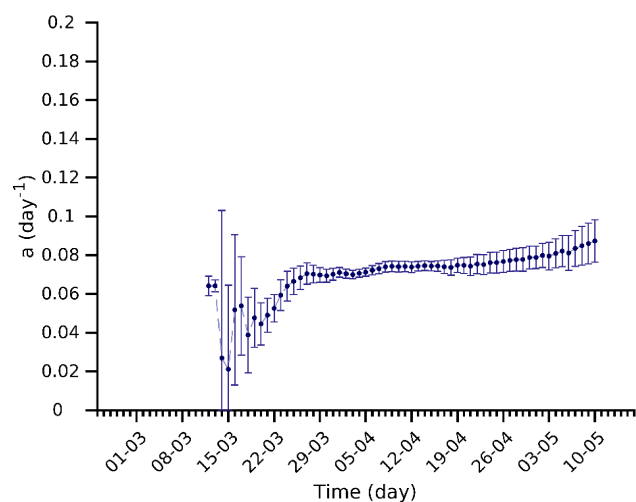
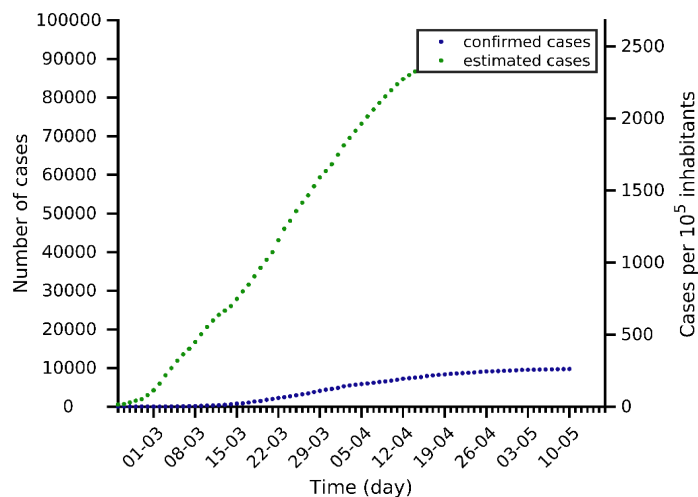
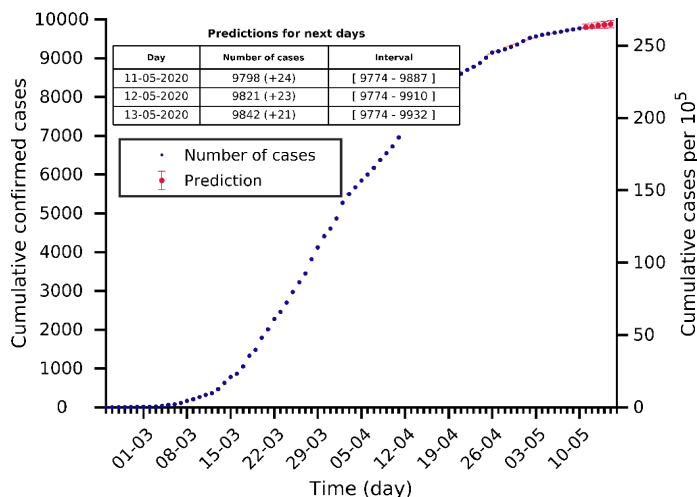
Emilia Romagna 10-05-2020. Population: 4.5M. Current cumulated incidence: 601/100000



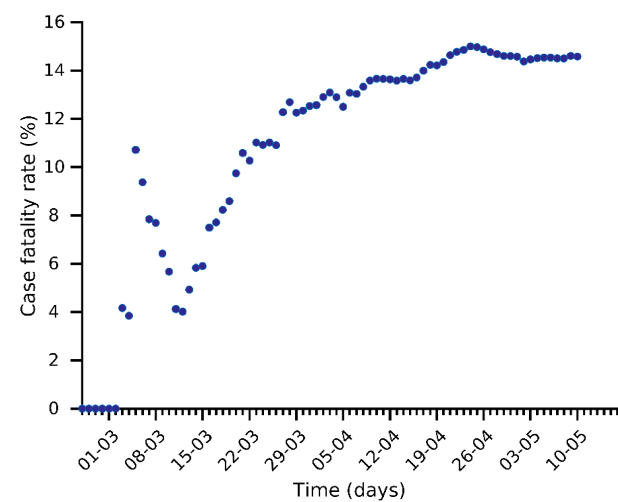
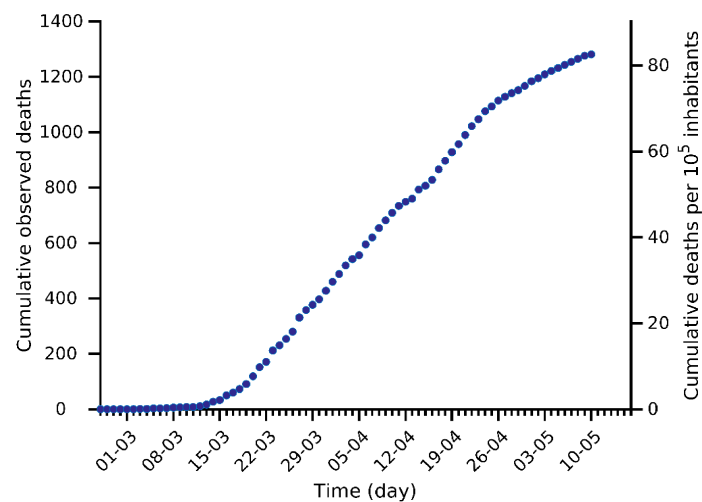
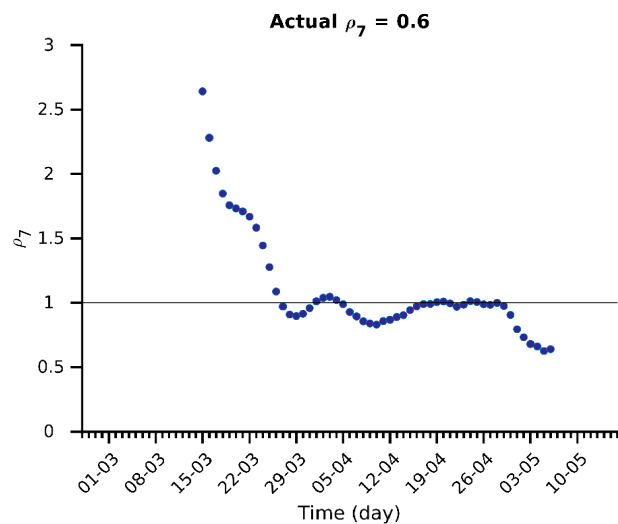
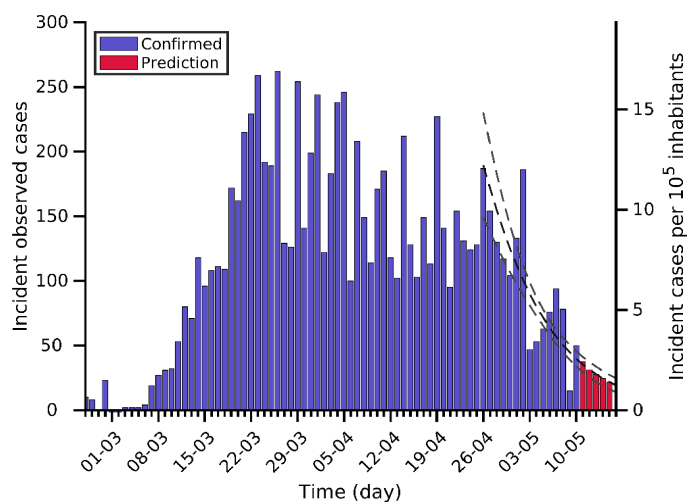
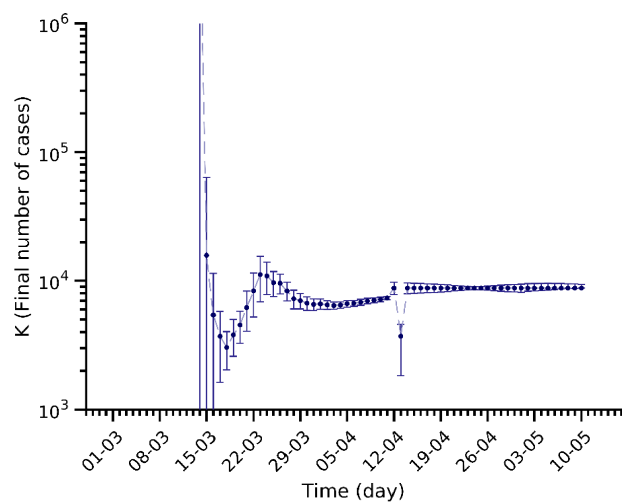
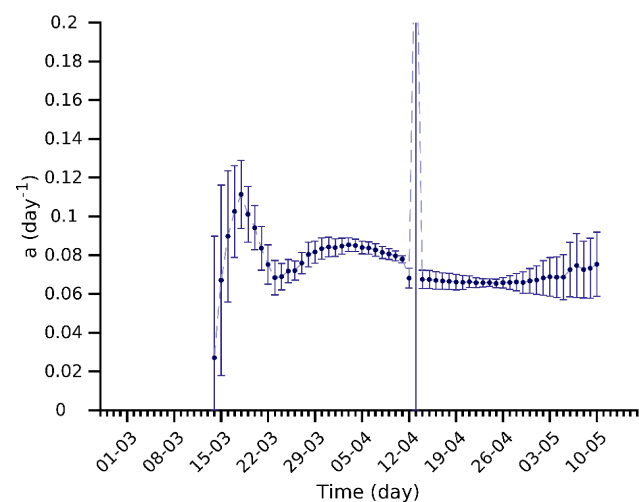
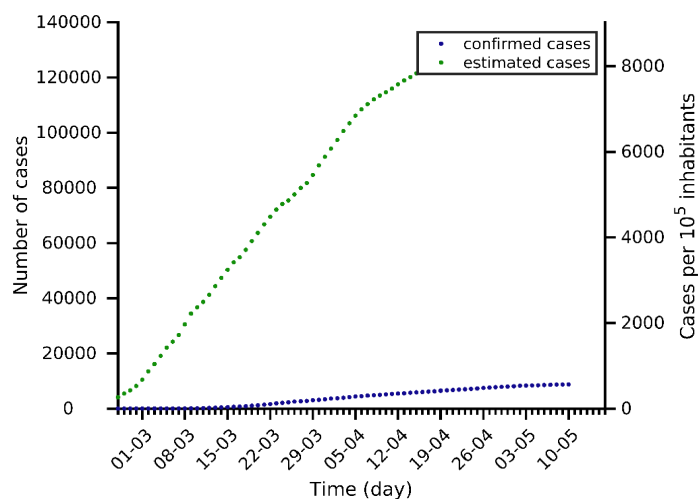
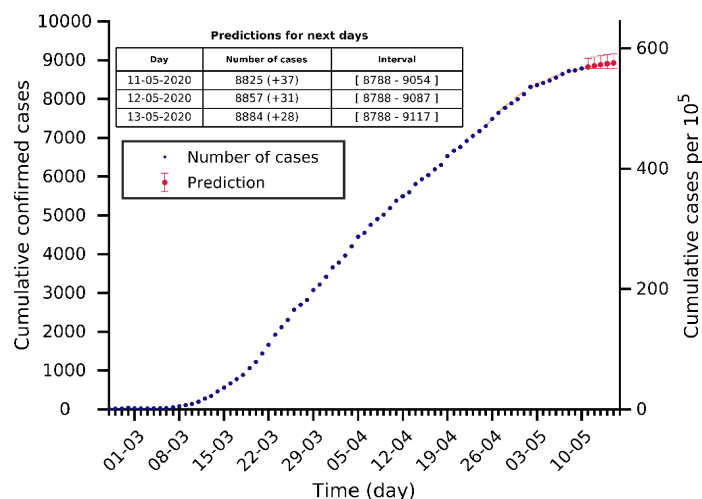
Veneto 10-05-2020. Population: 4.9M. Current cumulated incidence: 382/10⁵



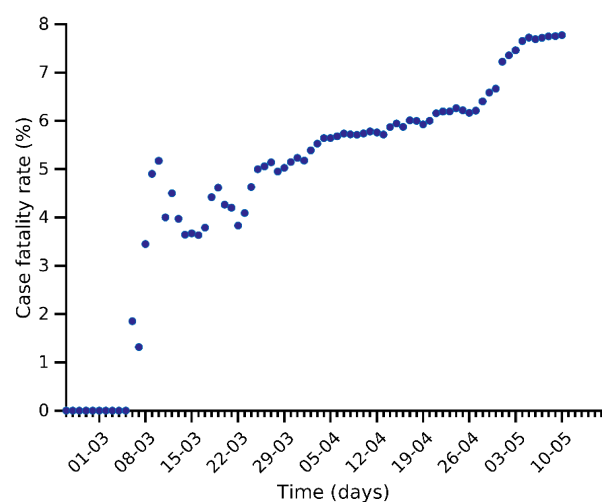
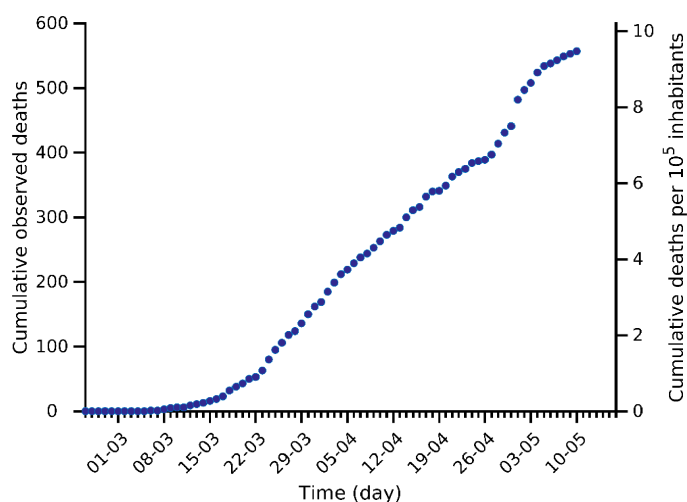
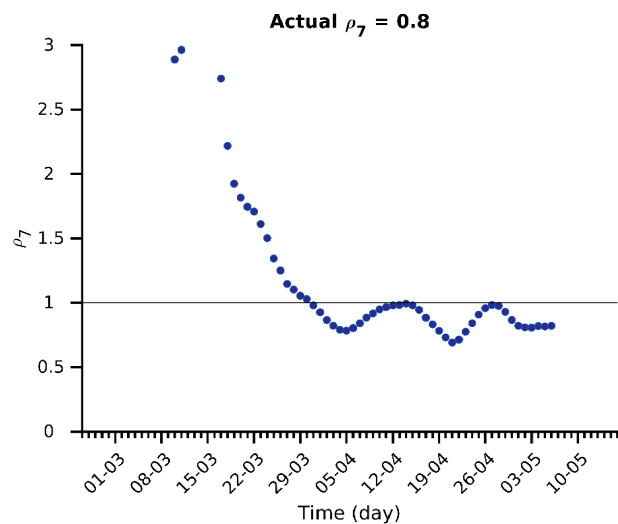
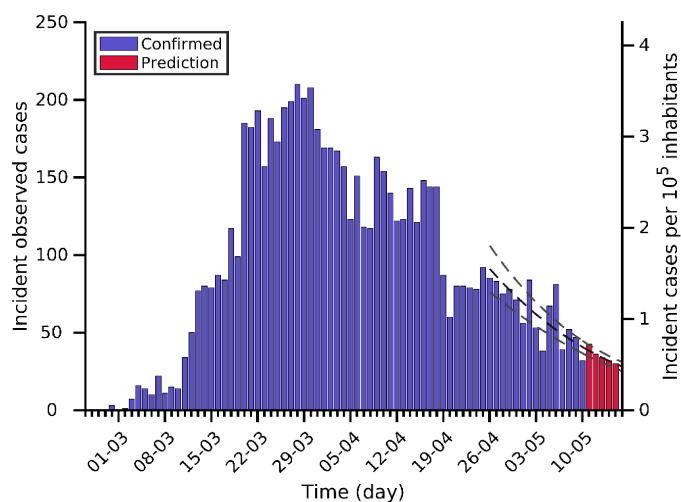
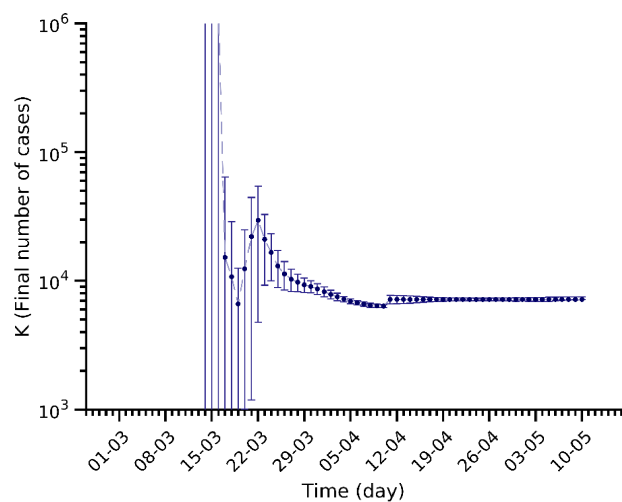
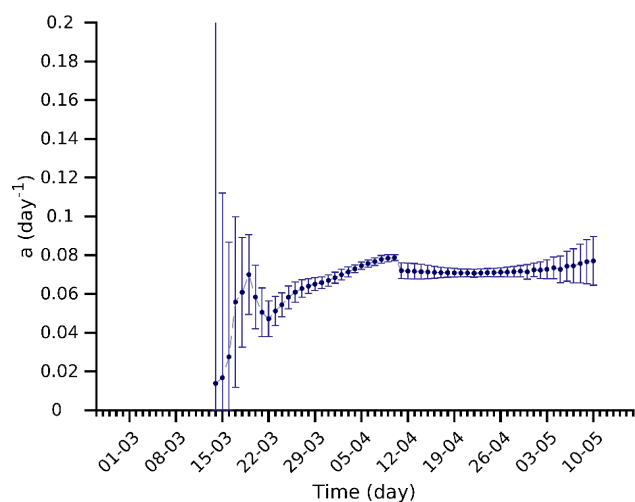
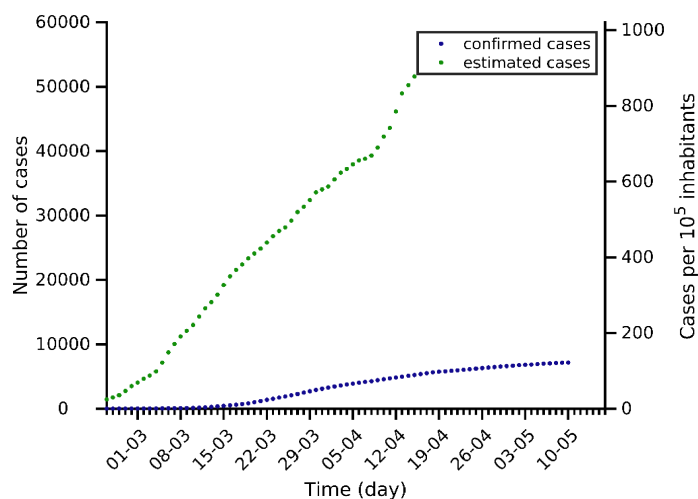
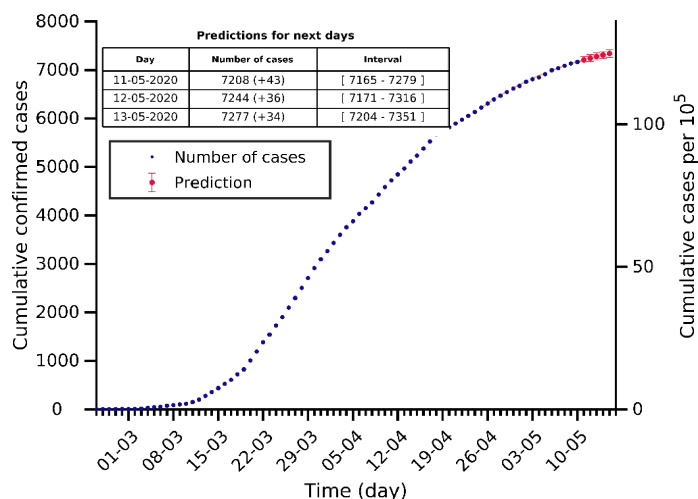
Toscana 10-05-2020. Population: 3.7M. Current cumulated incidence: 262/10⁵



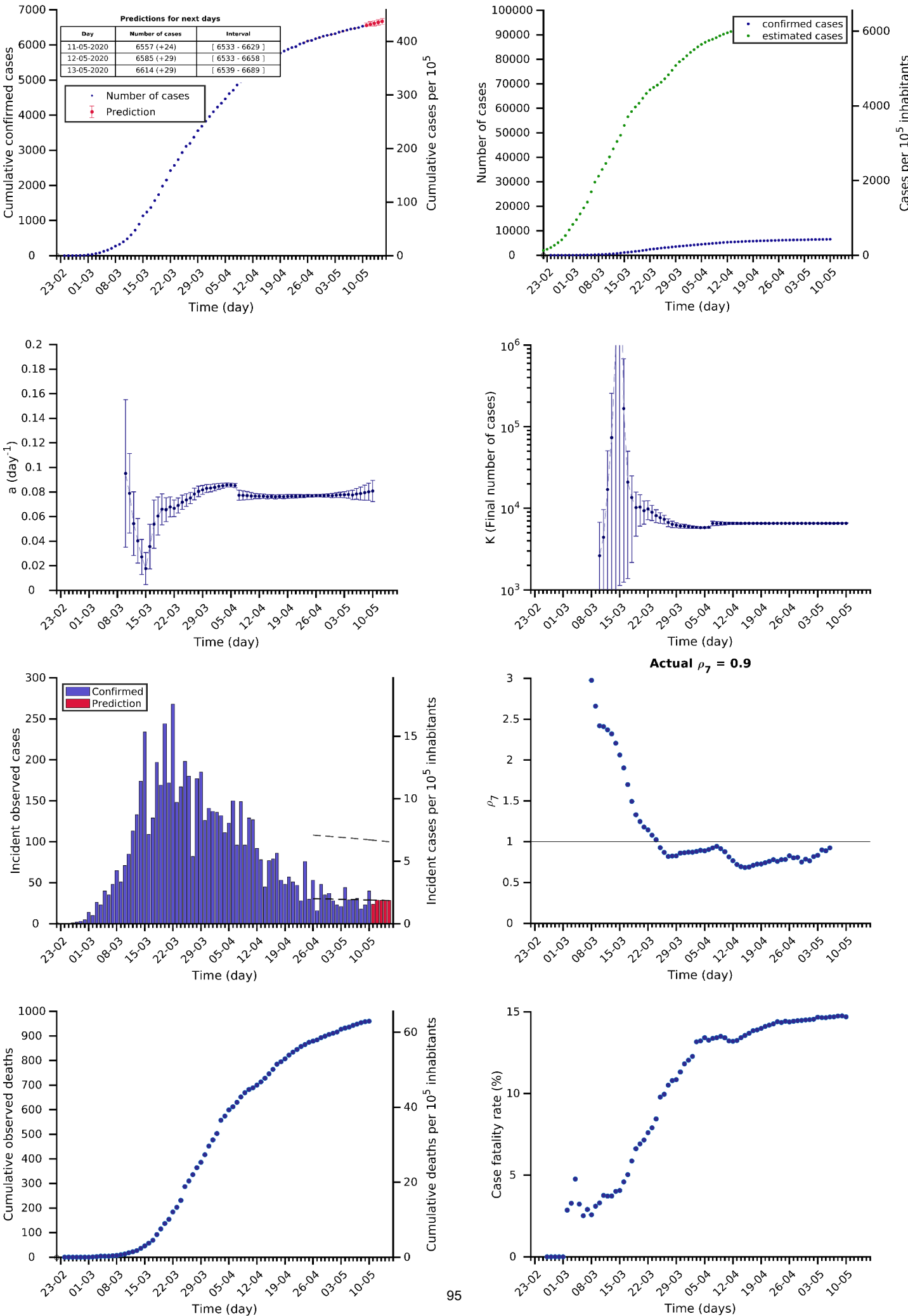
Liguria 10-05-2020. Population: 1.6M. Current cumulated incidence: 567/10⁵



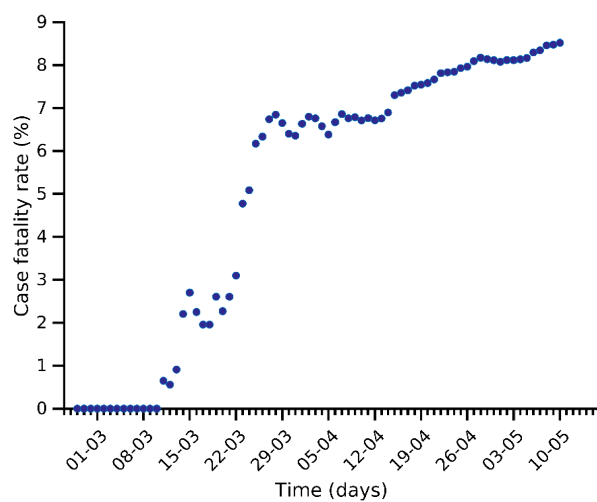
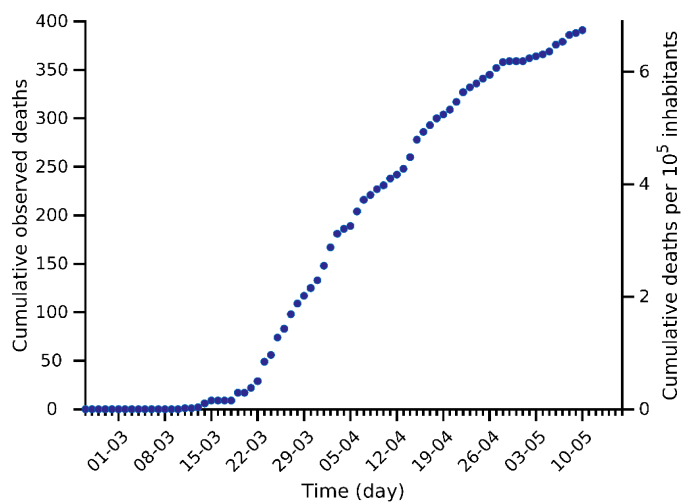
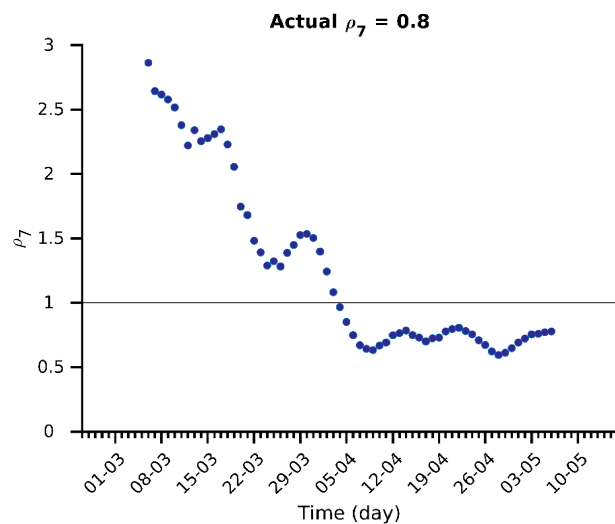
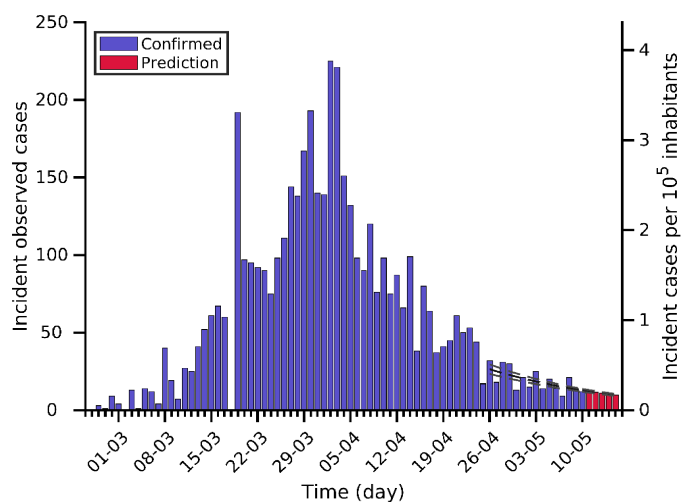
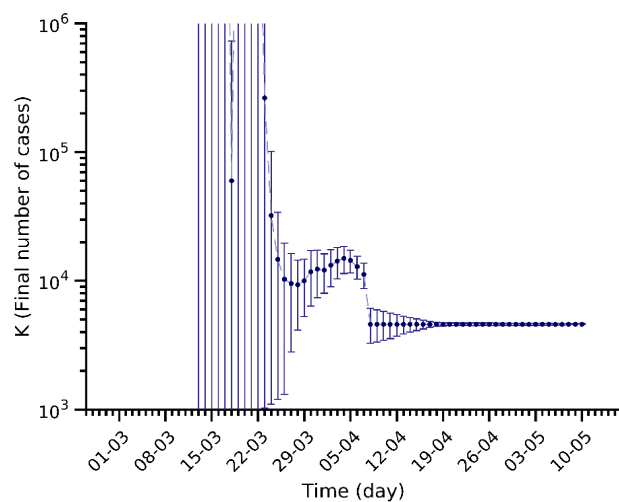
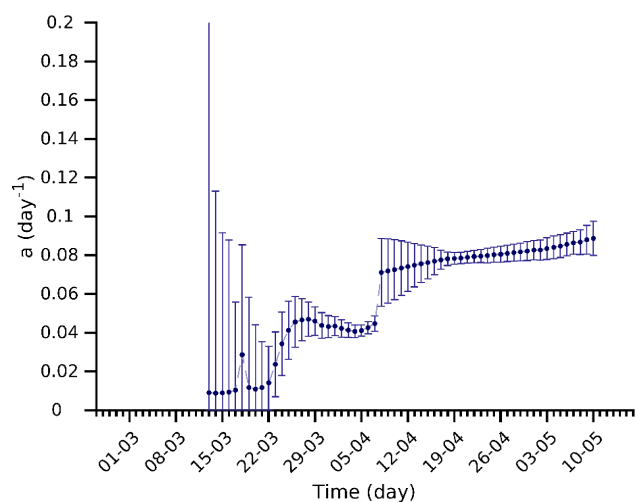
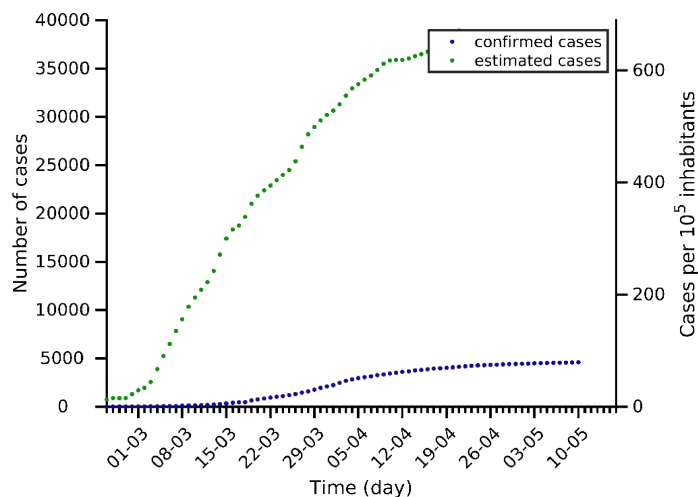
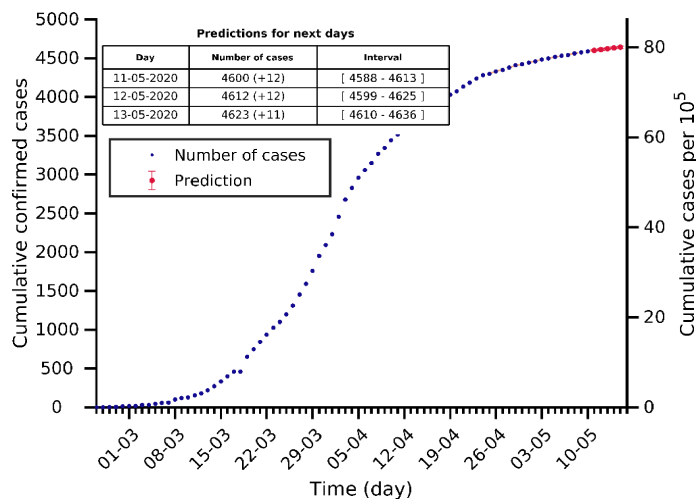
Lazio 10-05-2020. Population: 5.9M. Current cumulated incidence: 122/10⁵



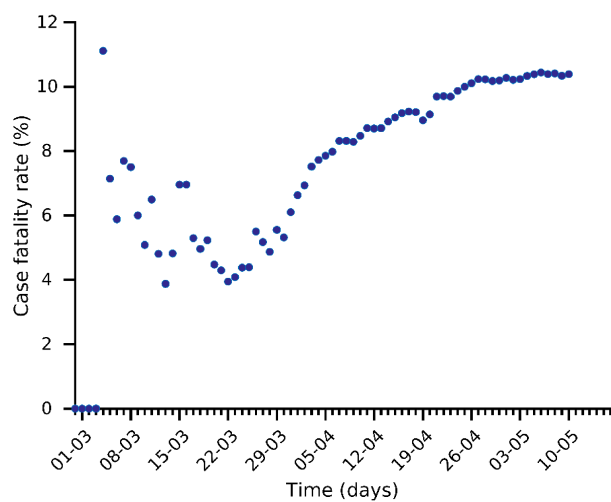
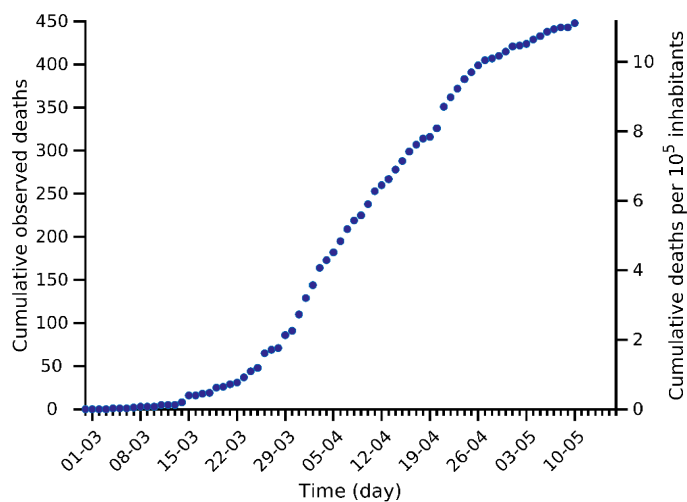
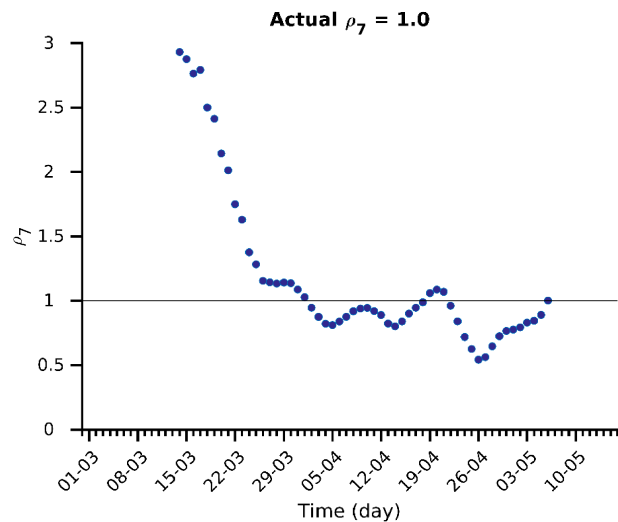
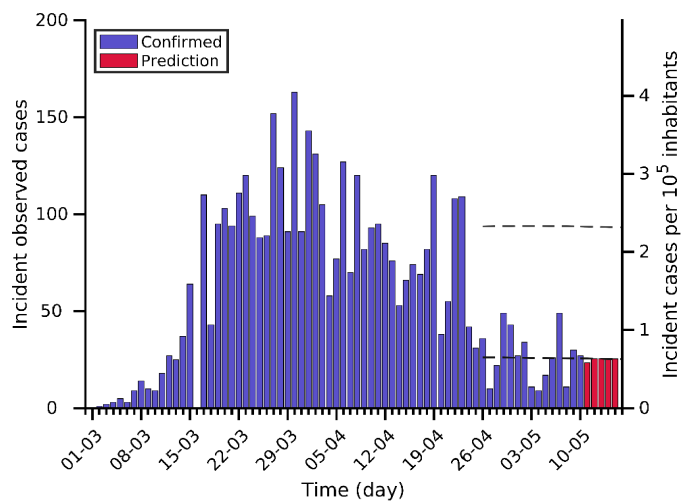
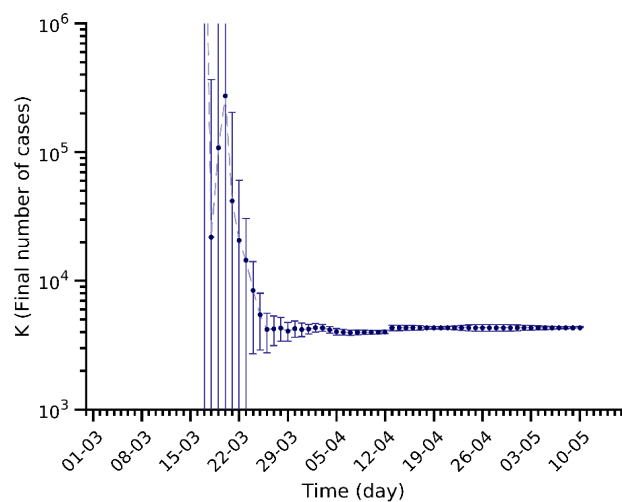
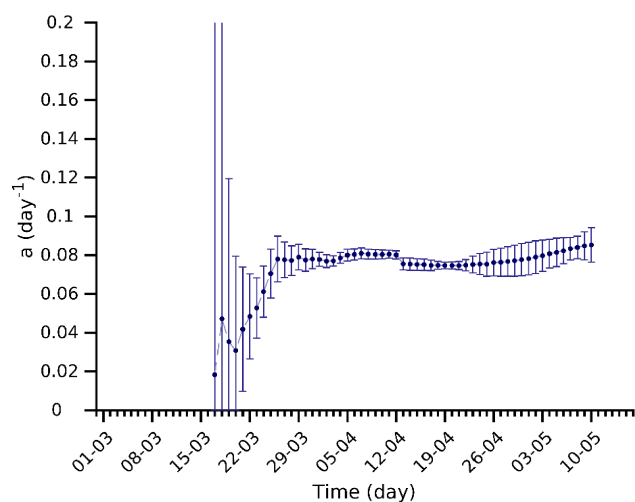
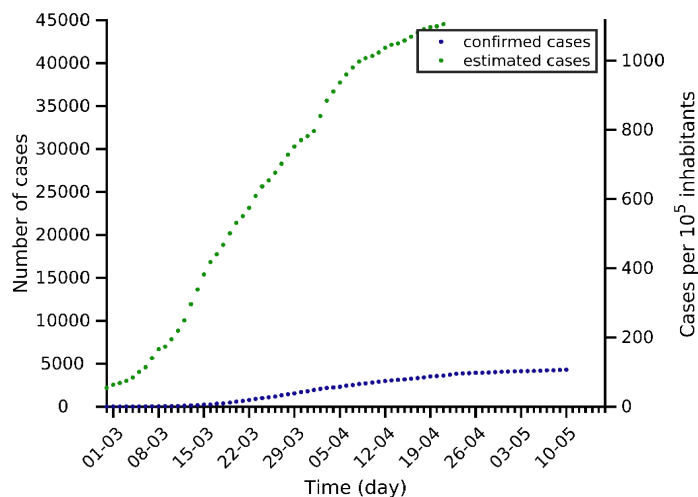
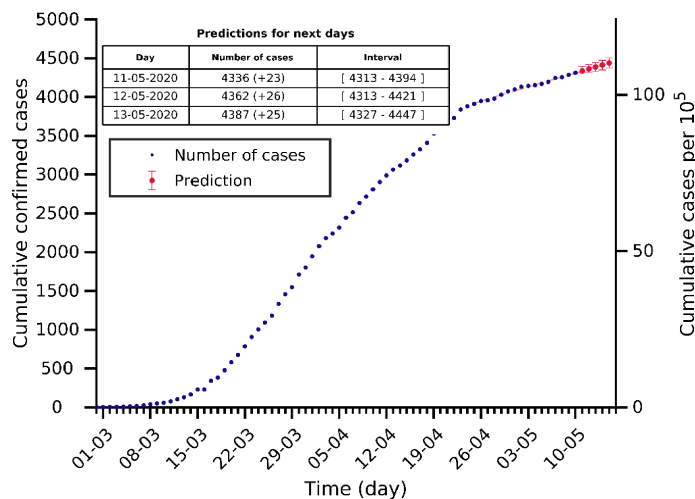
Marche
 10-05-2020.
 Population: 1.5M.
 Current cumulated incidence: 428/10⁵



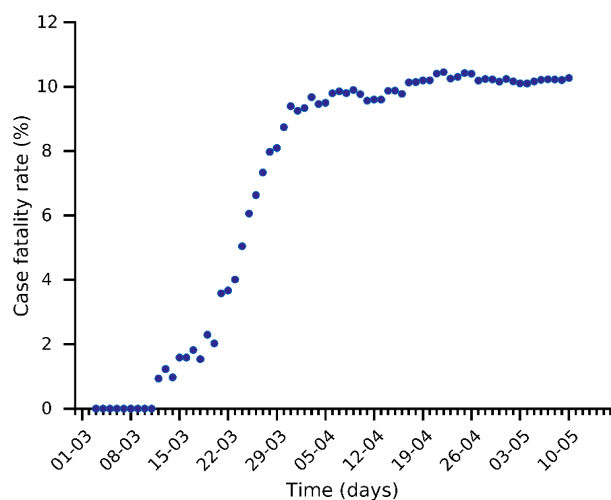
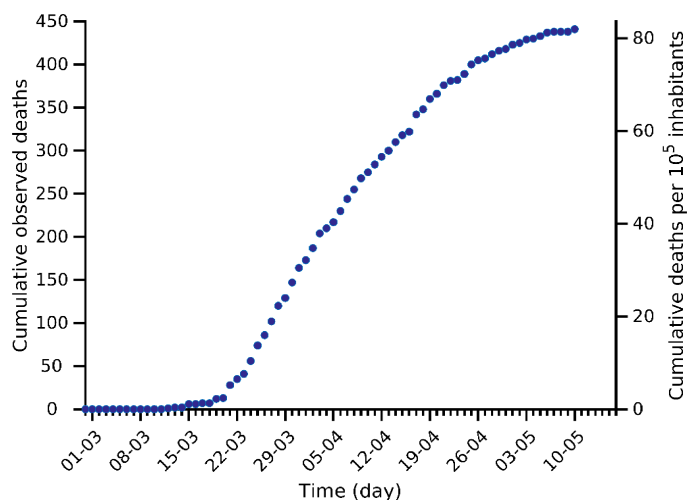
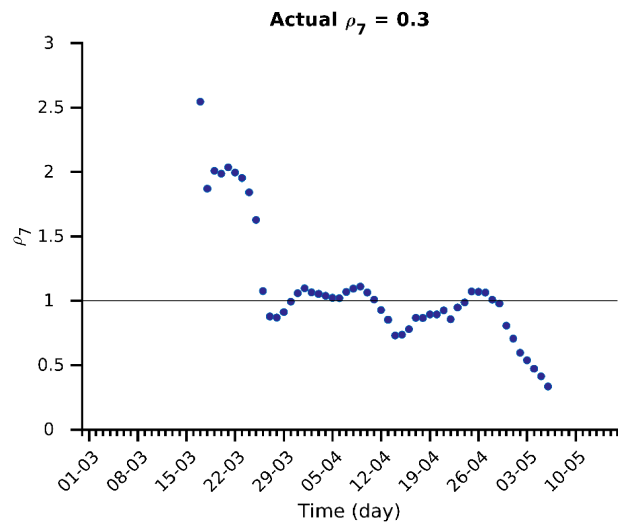
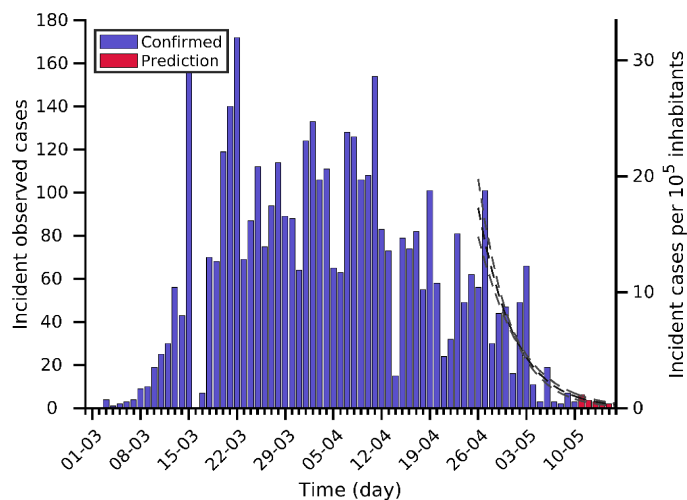
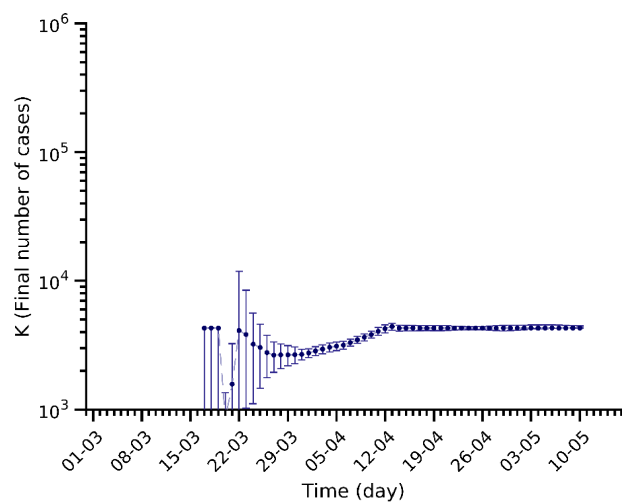
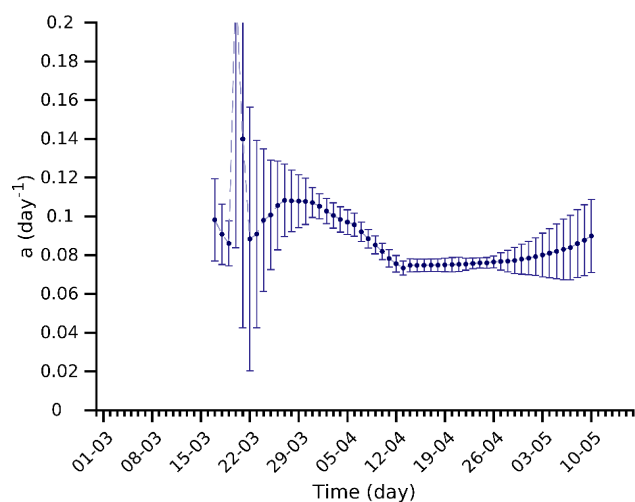
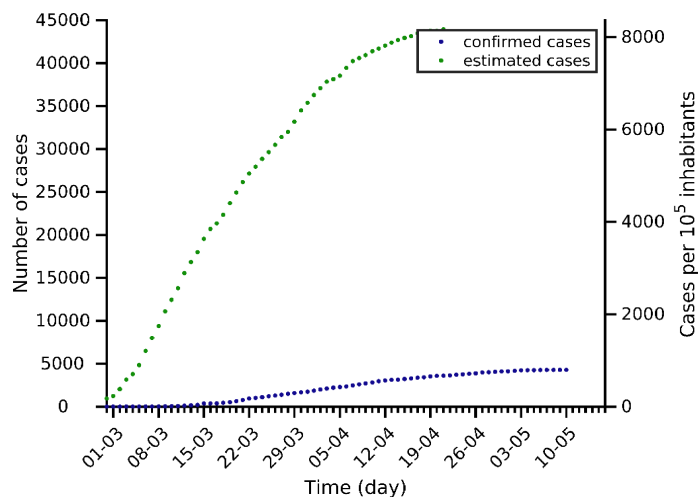
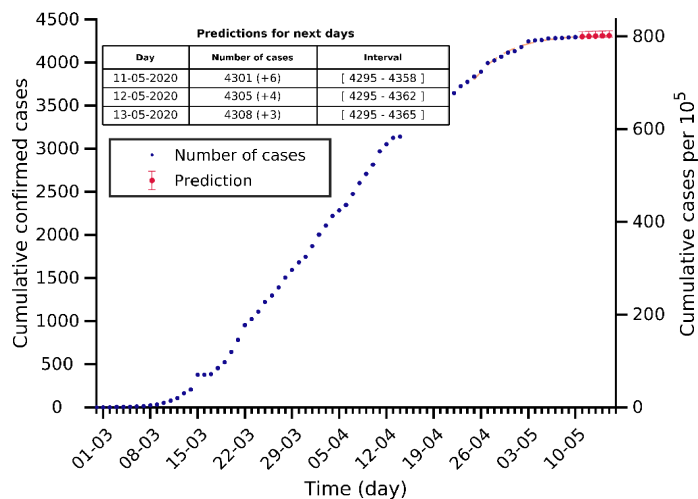
Campania 10-05-2020. Population: 5.8M. Current cumulated incidence: 79/10⁵



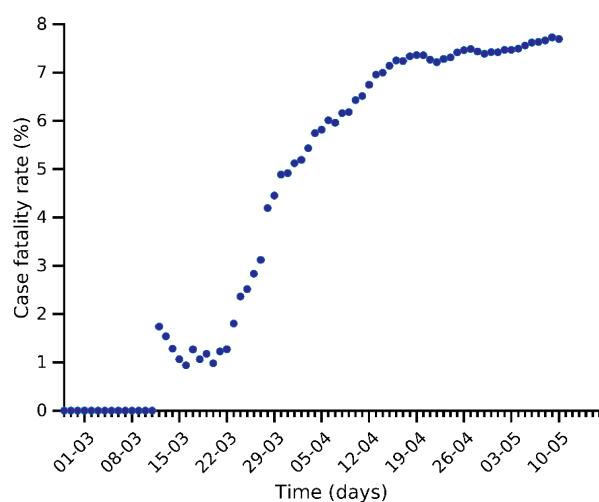
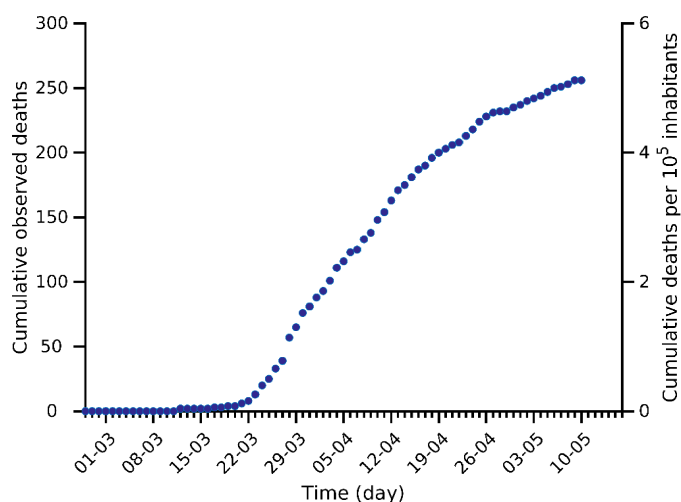
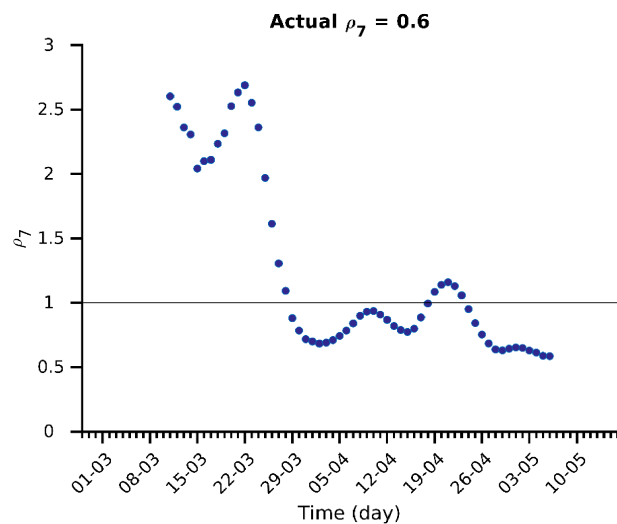
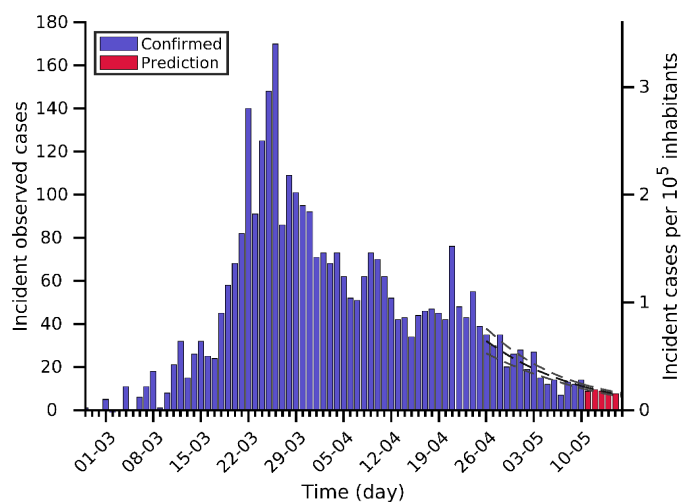
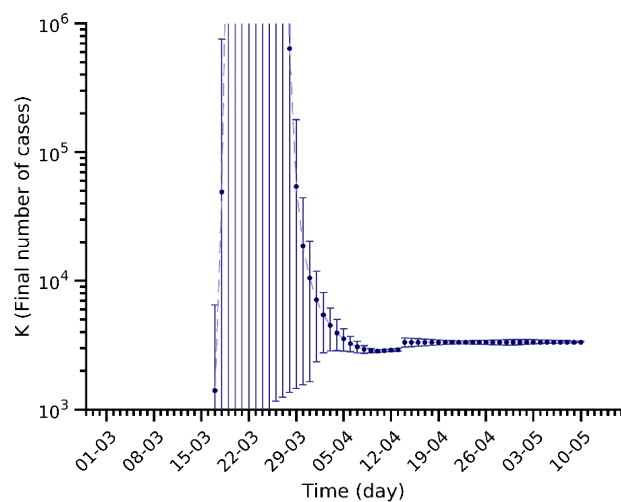
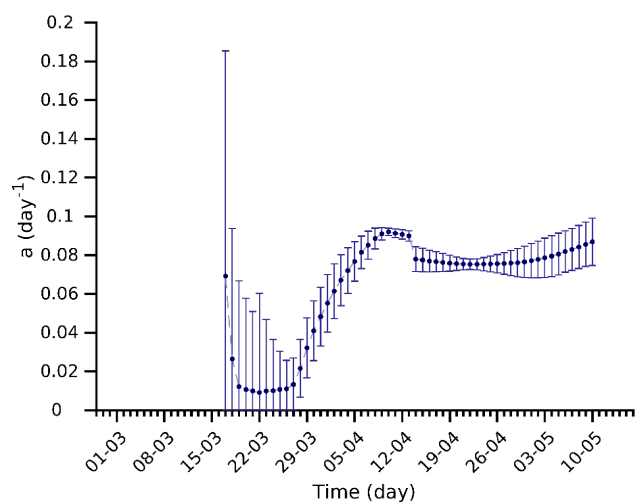
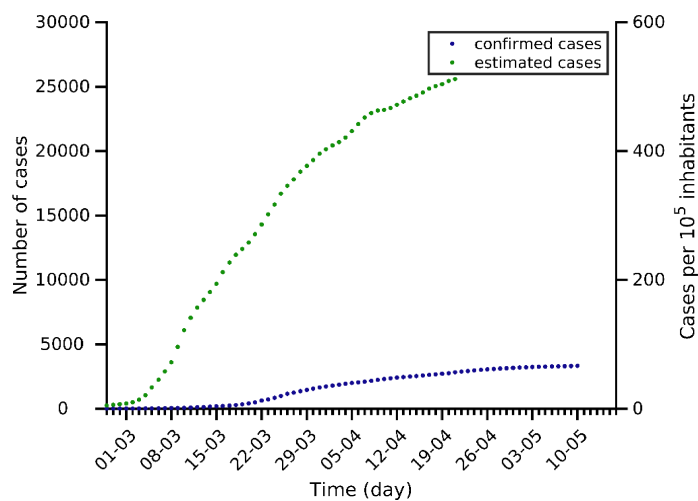
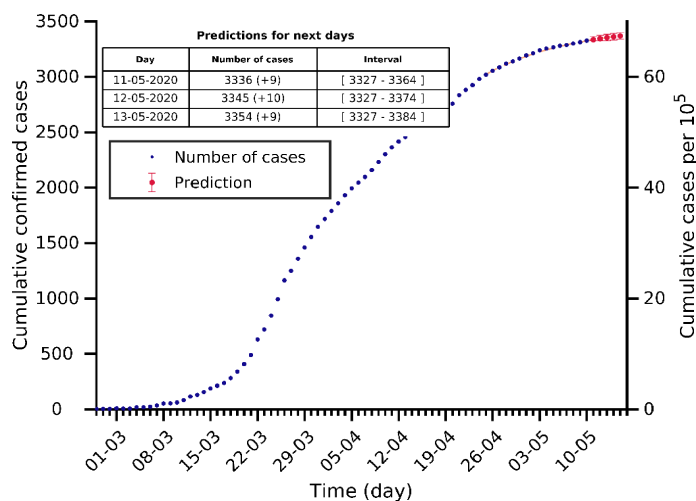
Puglia 10-05-2020. Population: 4.0M. Current cumulated incidence: 107/10⁵



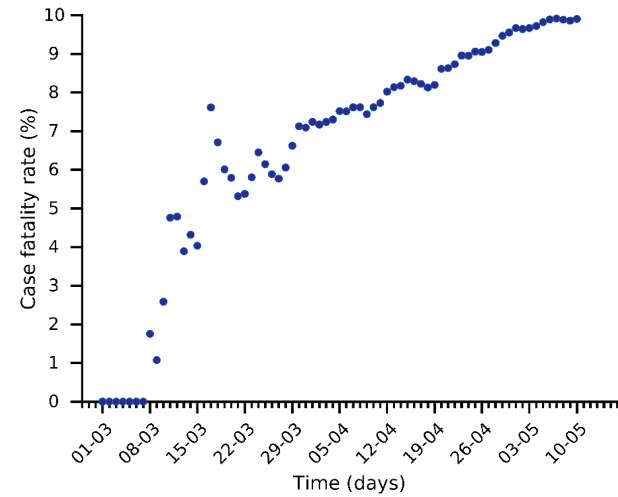
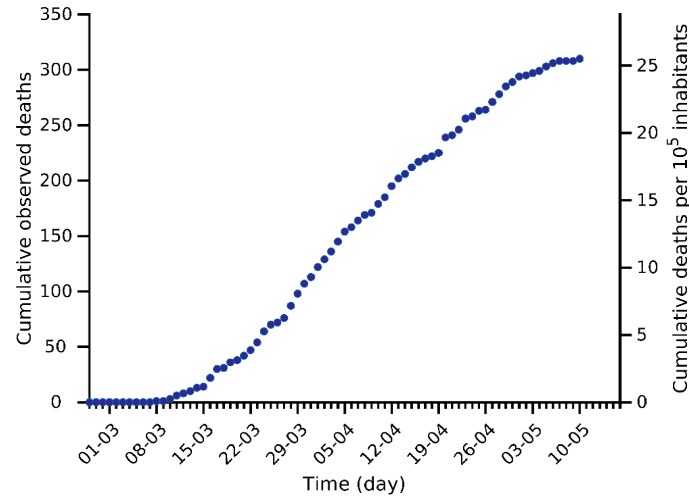
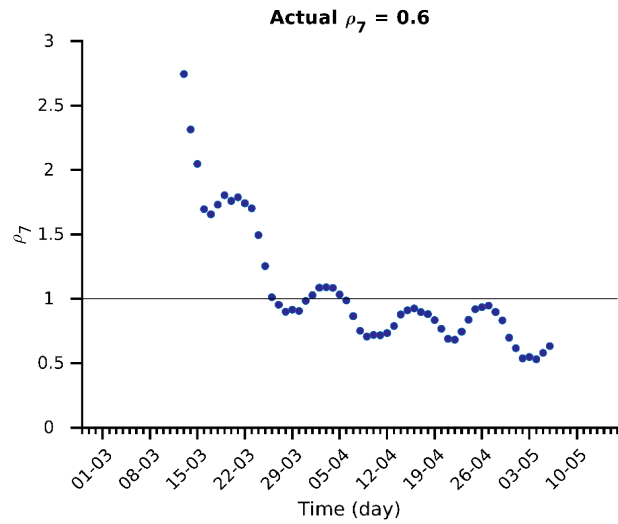
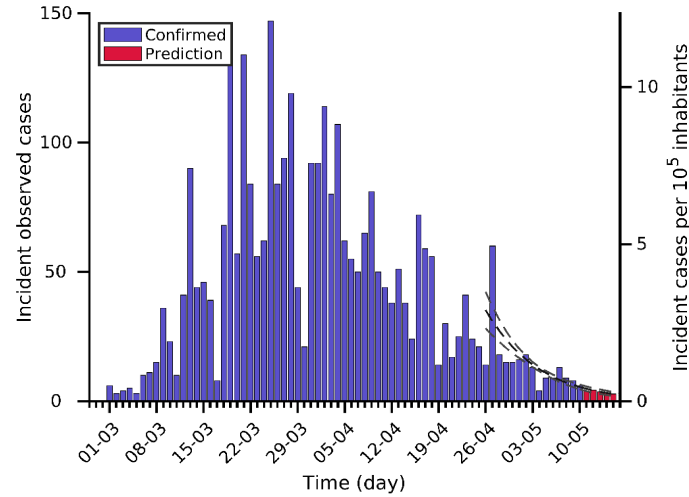
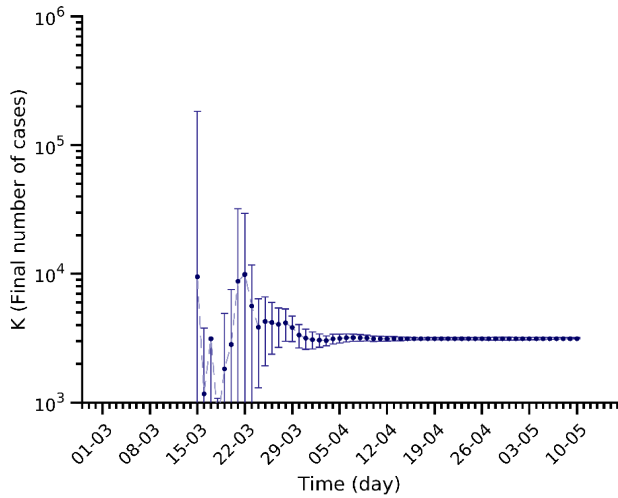
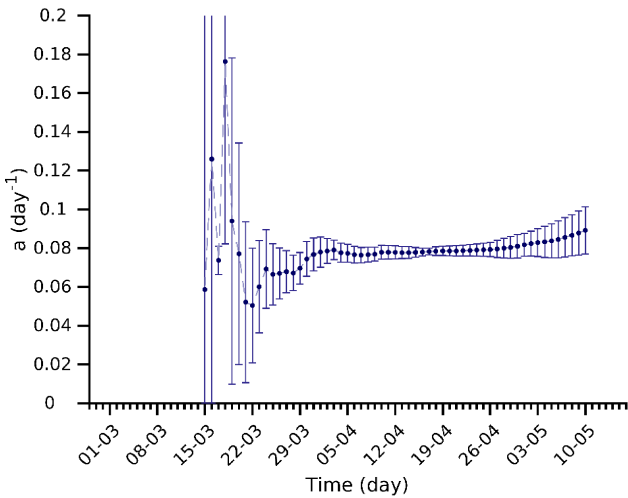
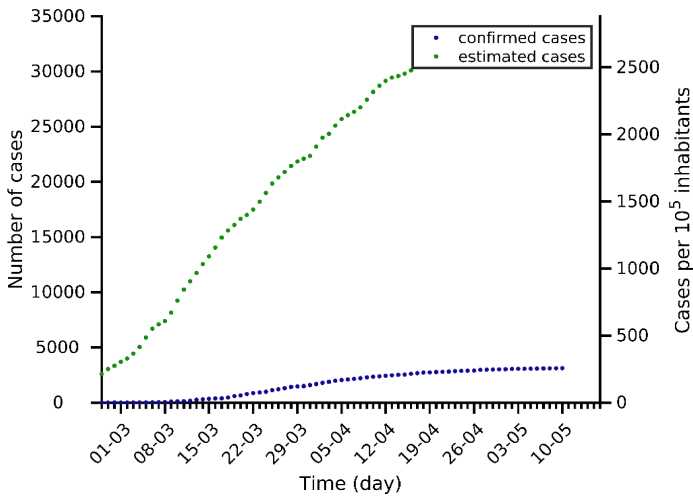
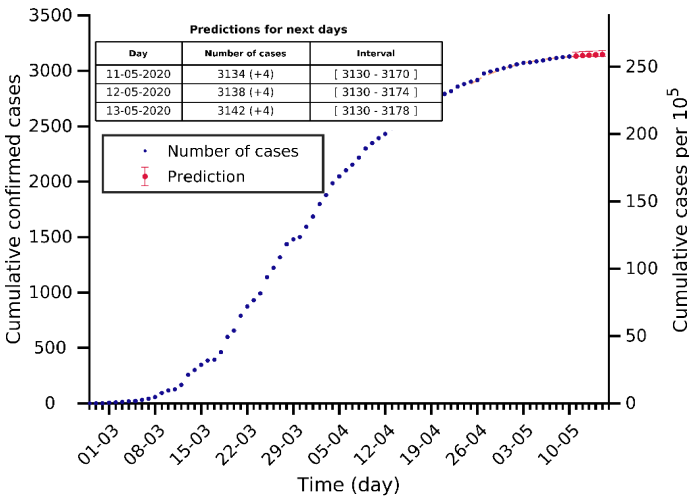
Trento 10-05-2020. Population: 0.5M. Current cumulated incidence: 798/10⁵



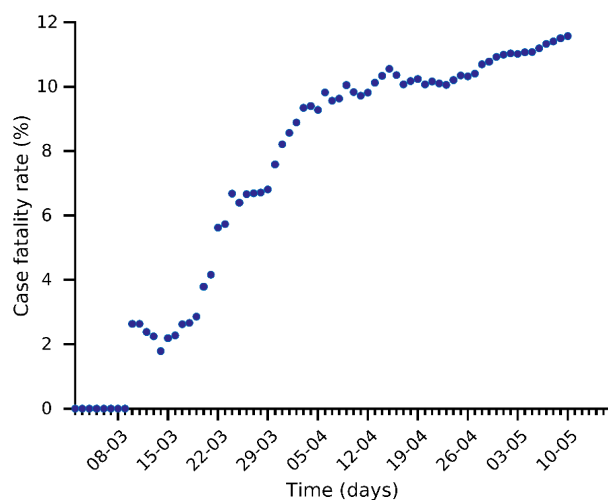
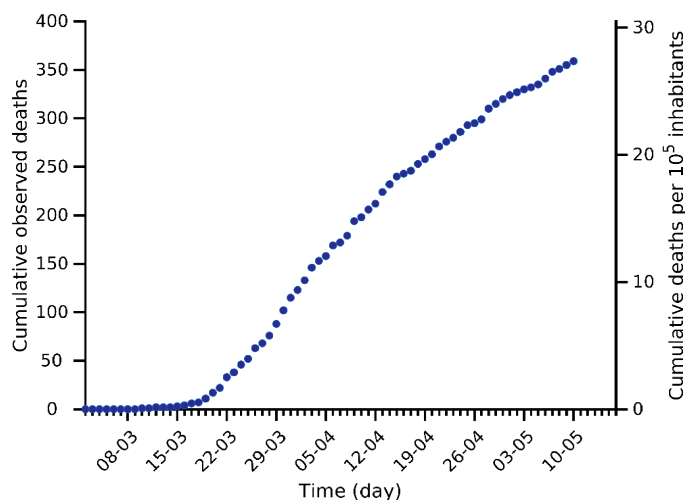
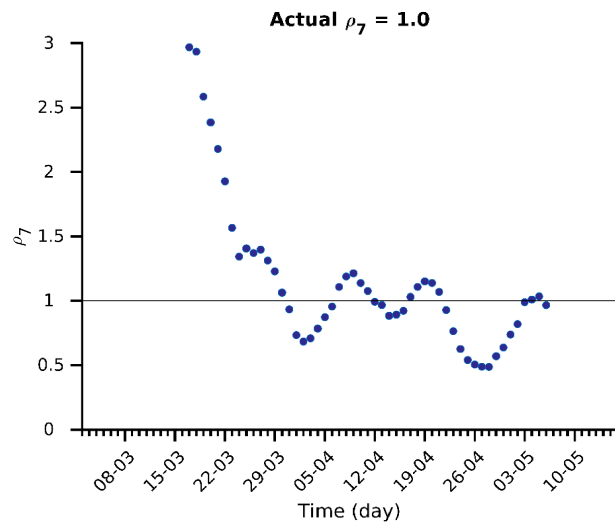
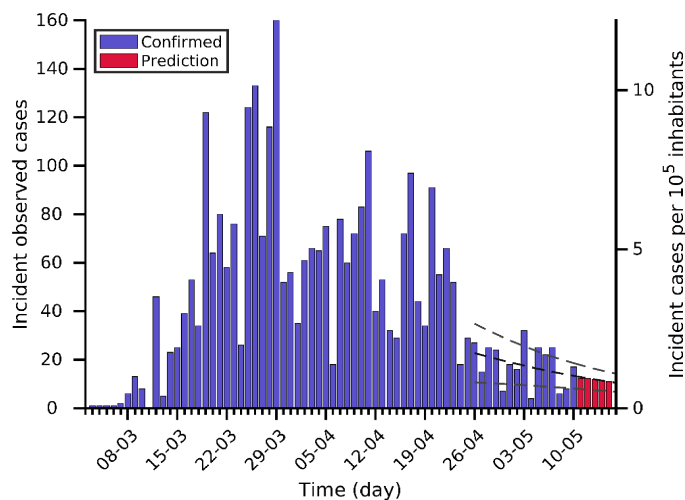
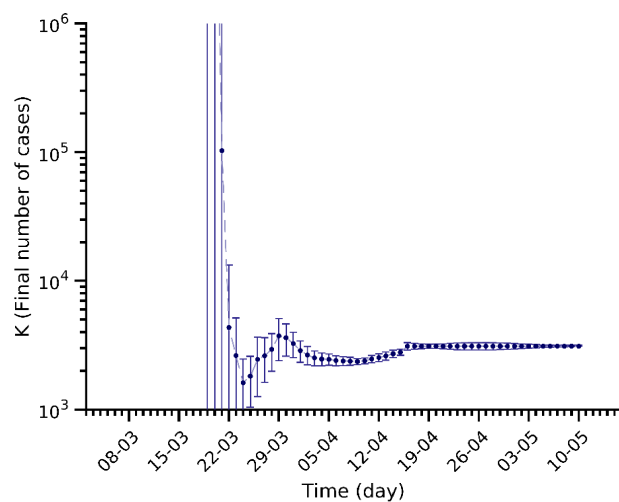
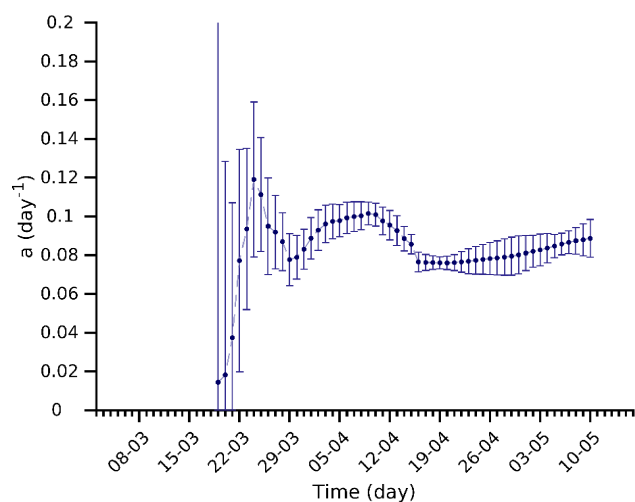
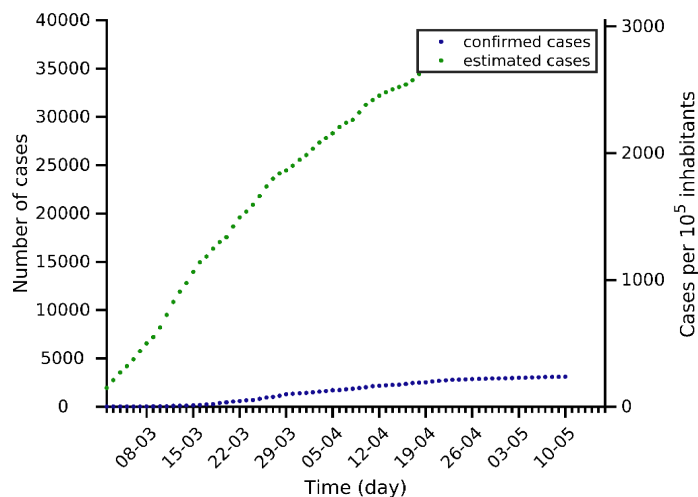
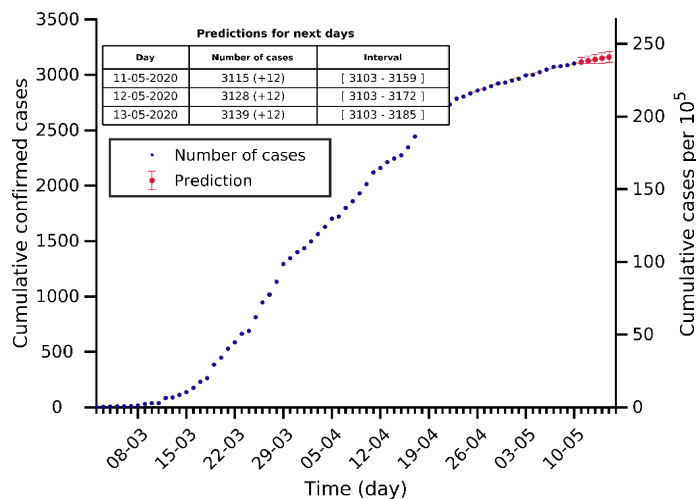
Sicilia 10-05-2020. Population: 5.0M. Current cumulated incidence: 67/10⁵



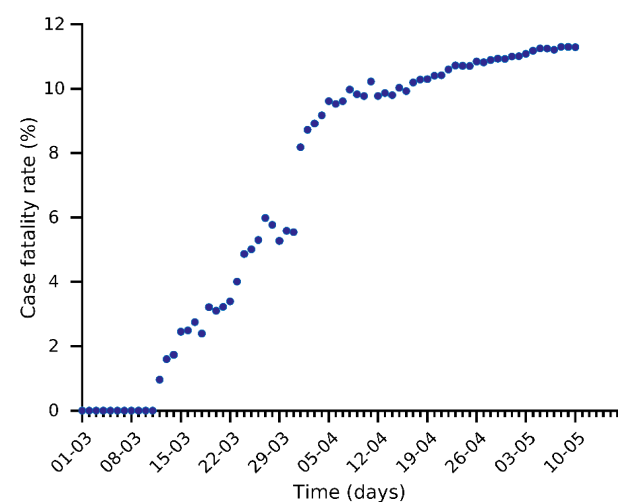
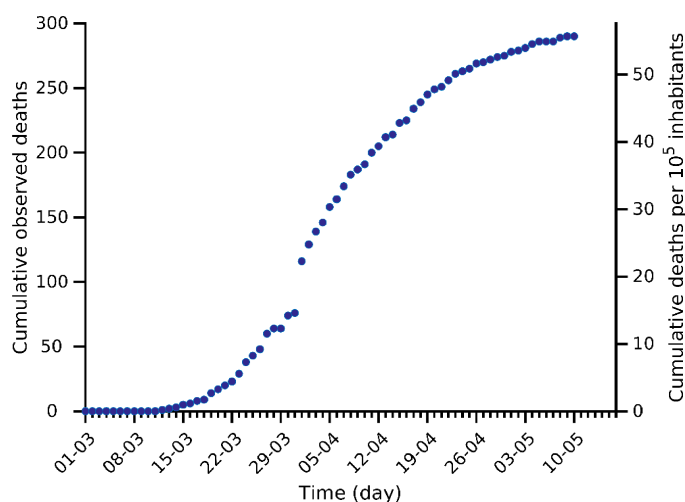
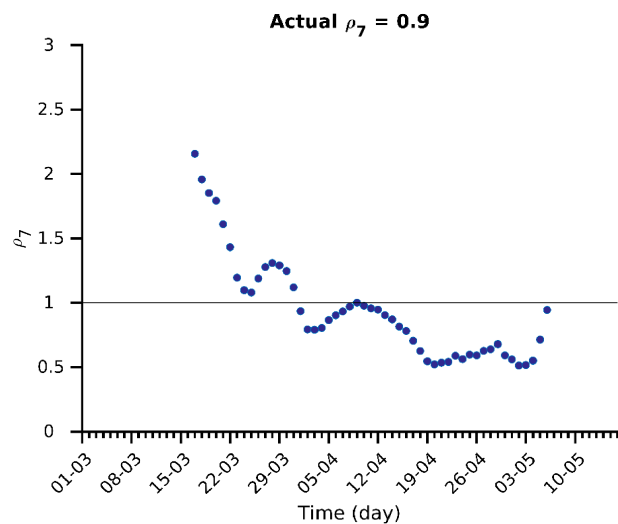
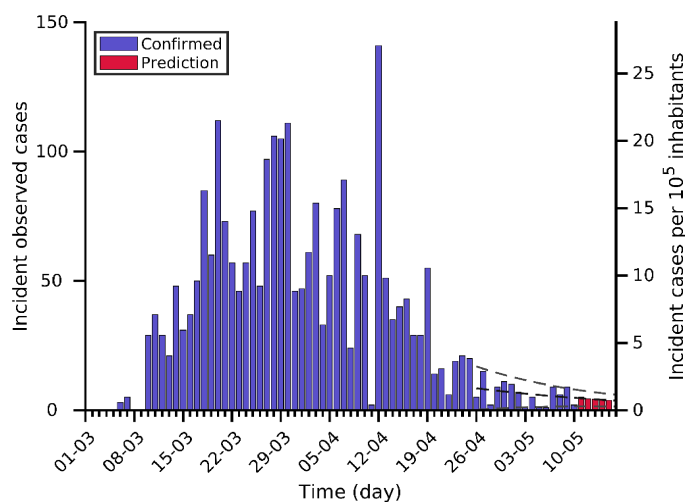
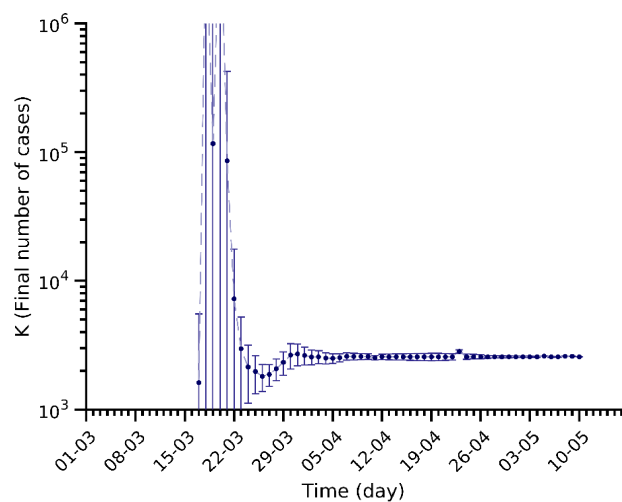
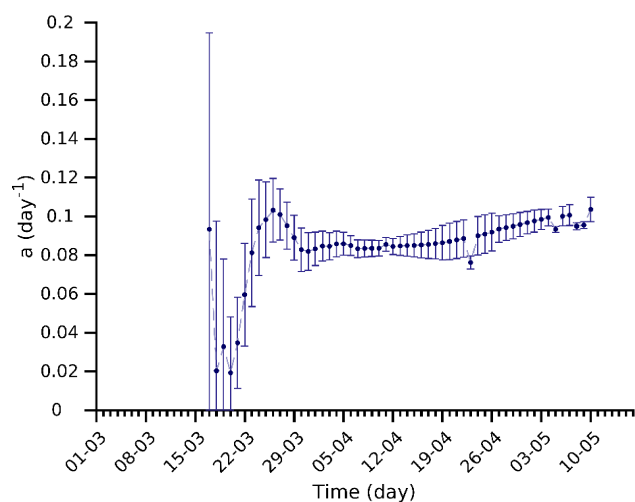
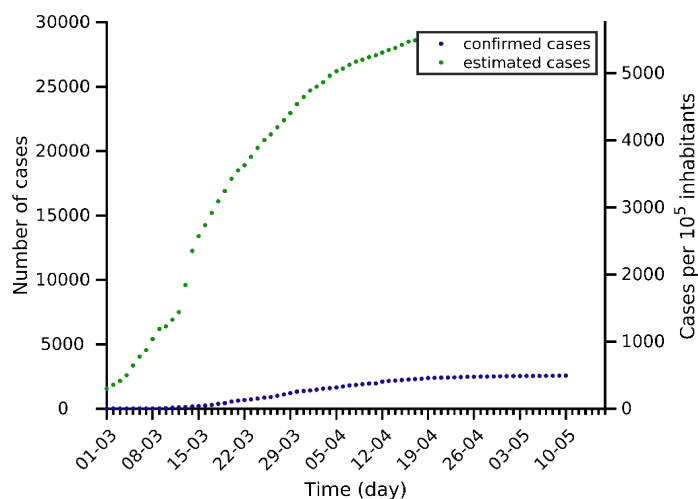
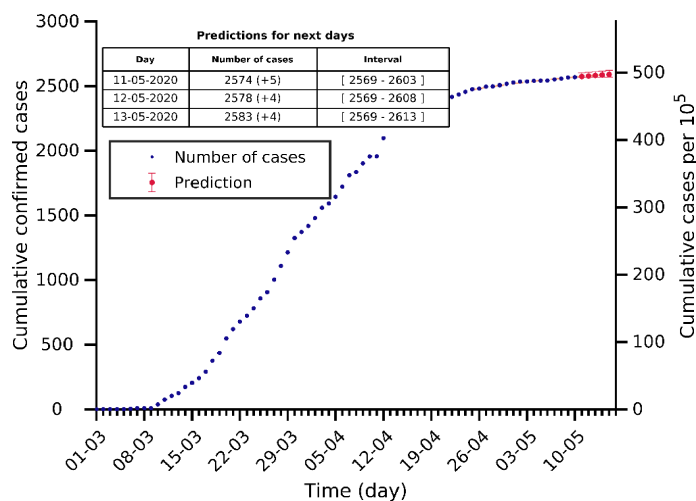
Friuli Venezia Giulia 10-05-2020. Population: 1.2M. Current cumulated incidence: 2



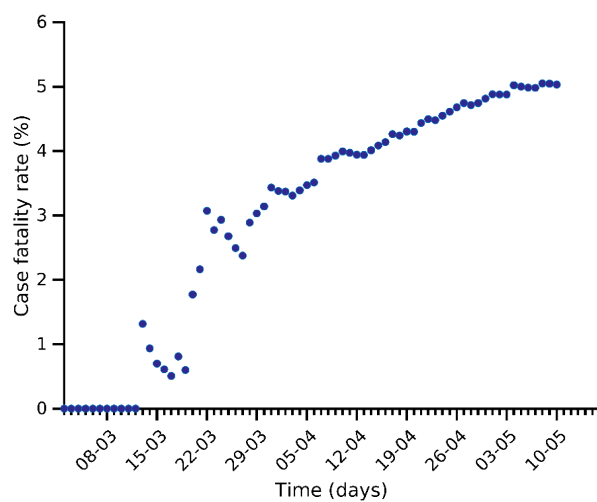
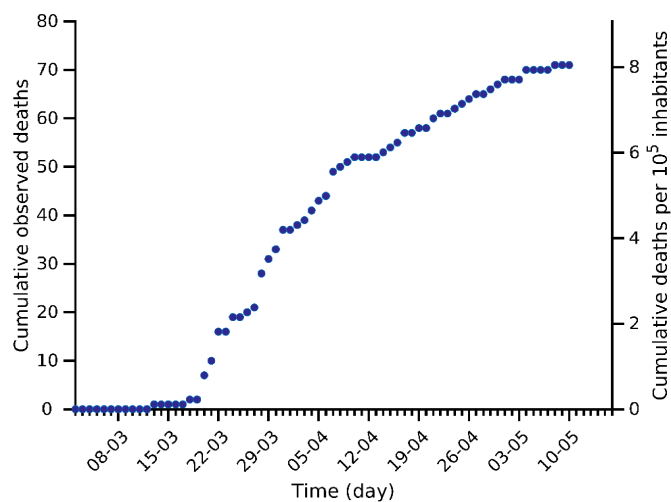
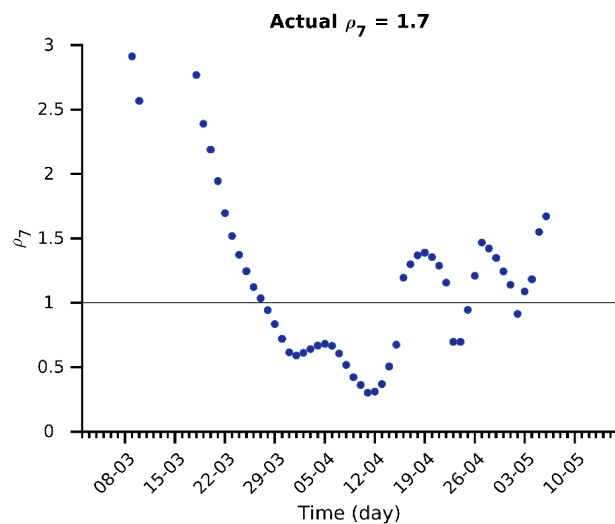
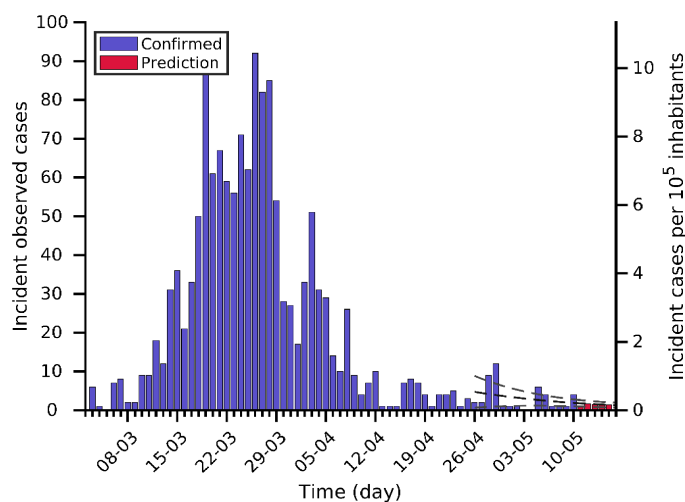
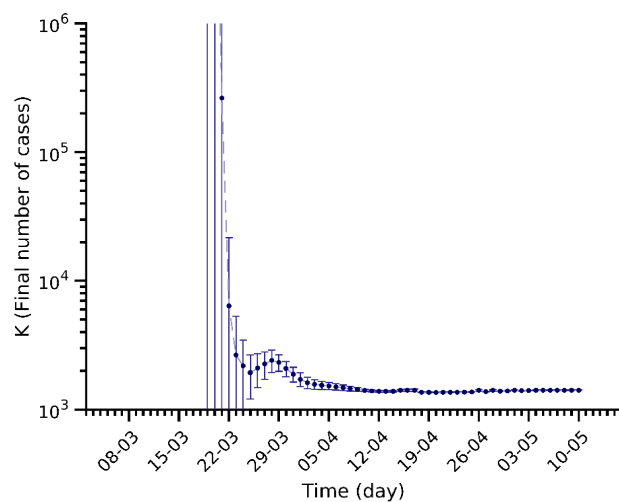
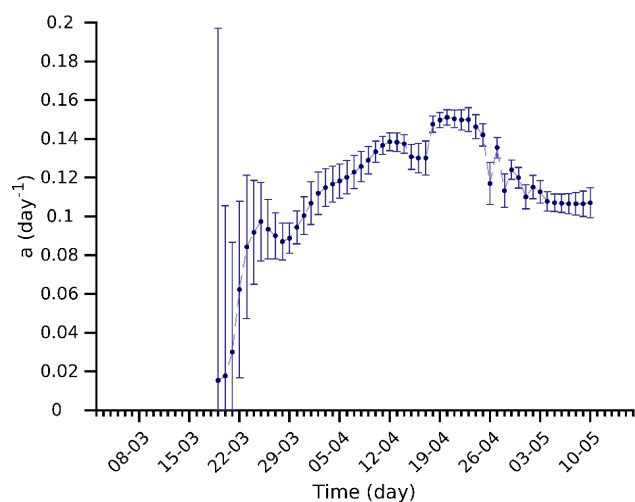
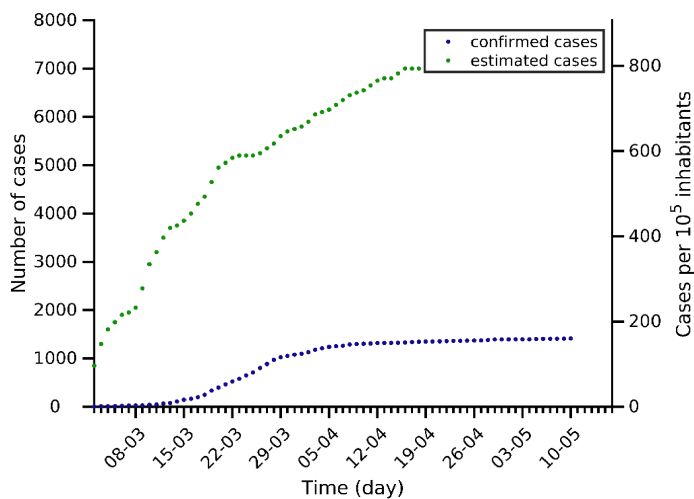
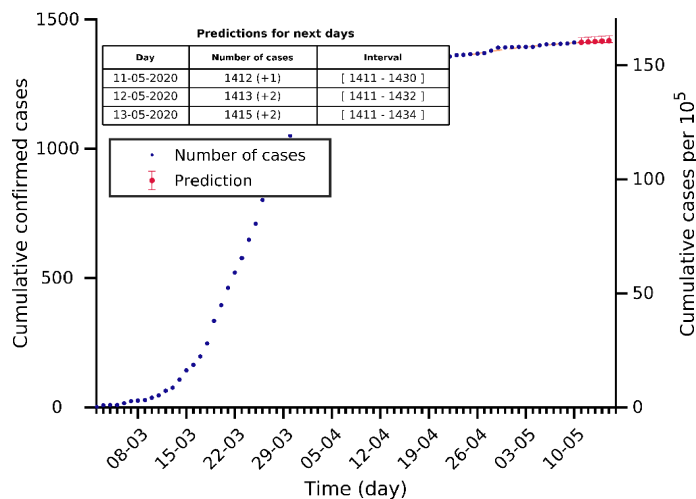
Abruzzo 10-05-2020. Population: 1.3M. Current cumulated incidence: 237/10⁵



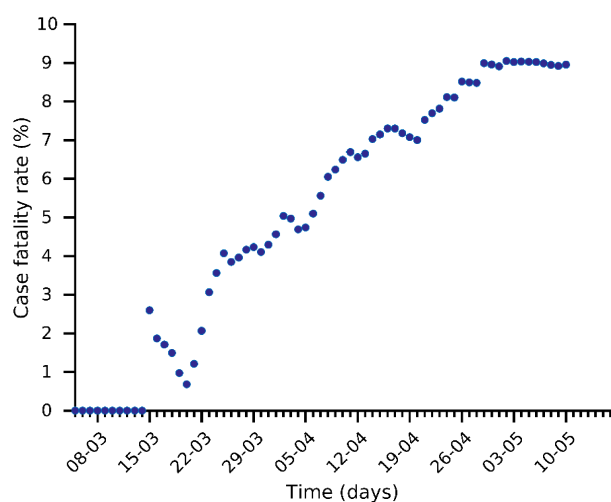
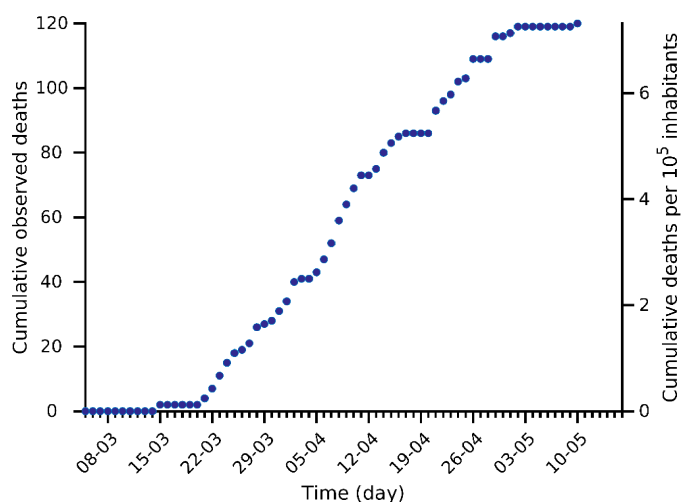
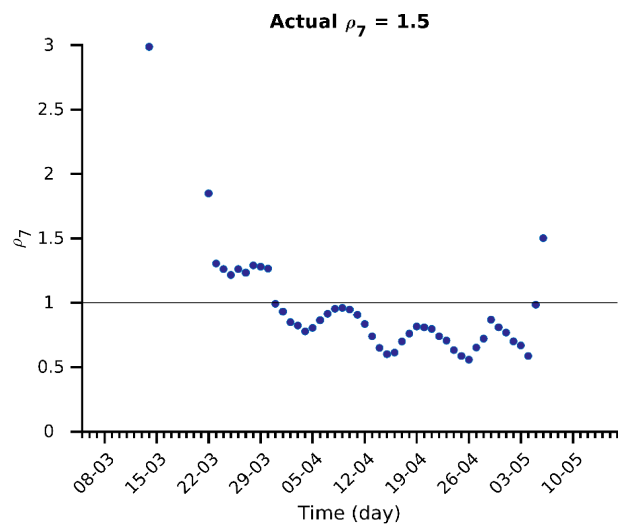
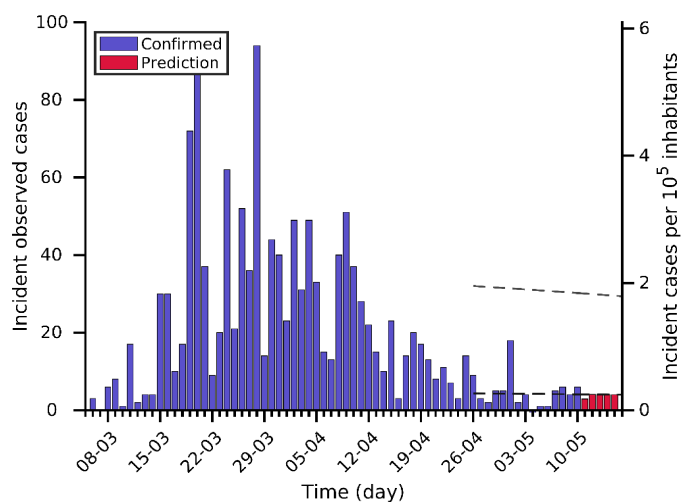
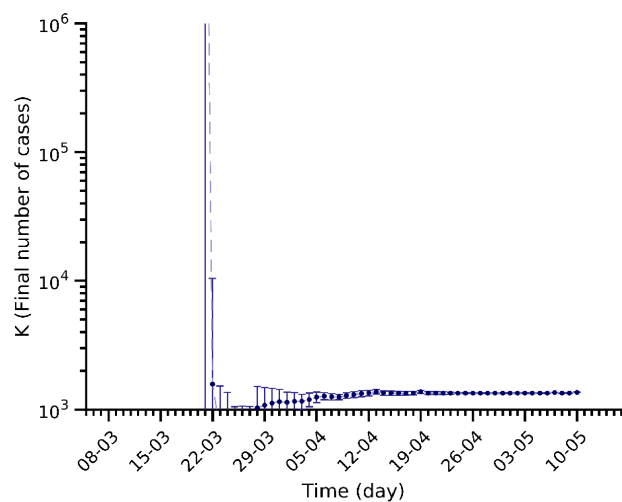
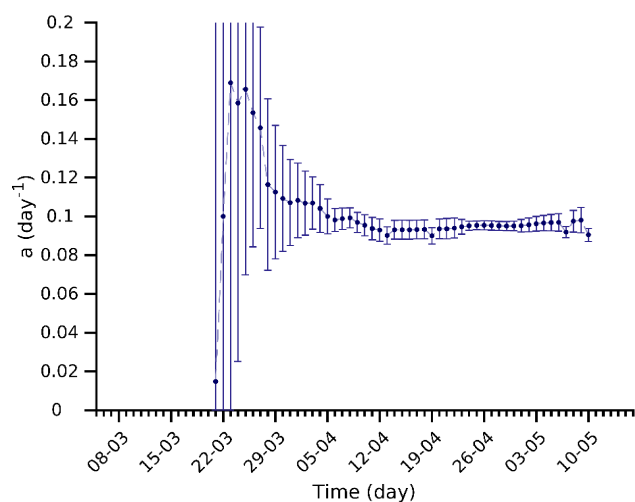
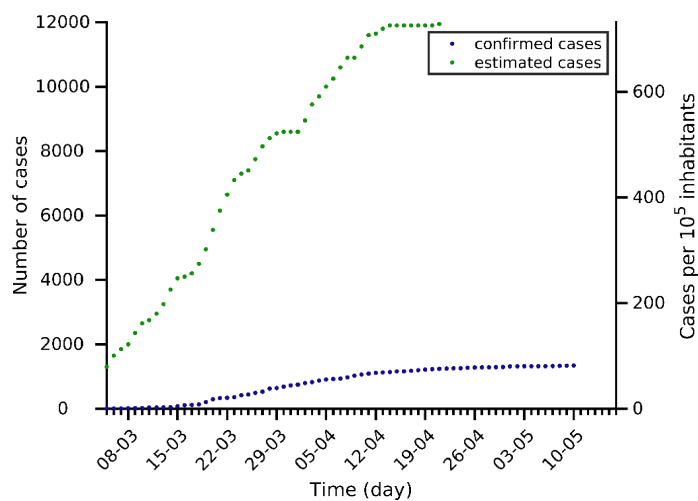
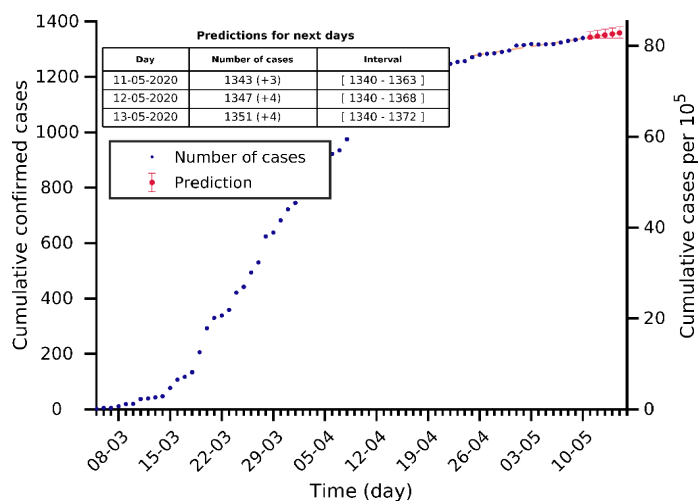
Bolzano 10-05-2020. Population: 0.5M. Current cumulated incidence: 493/10⁵



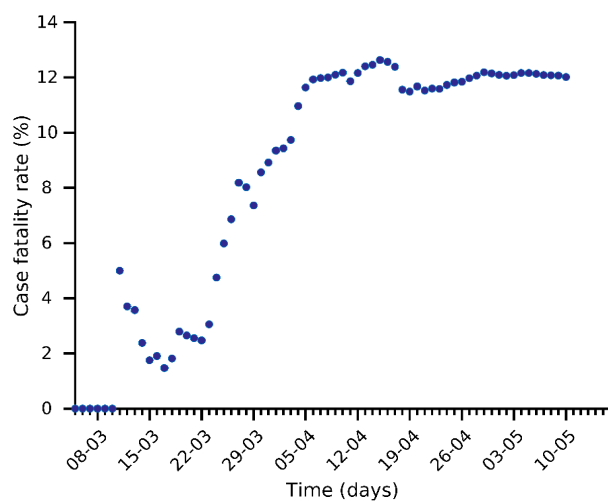
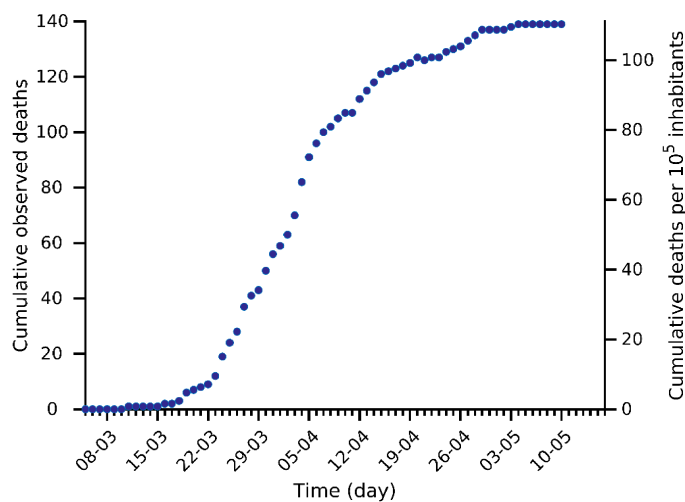
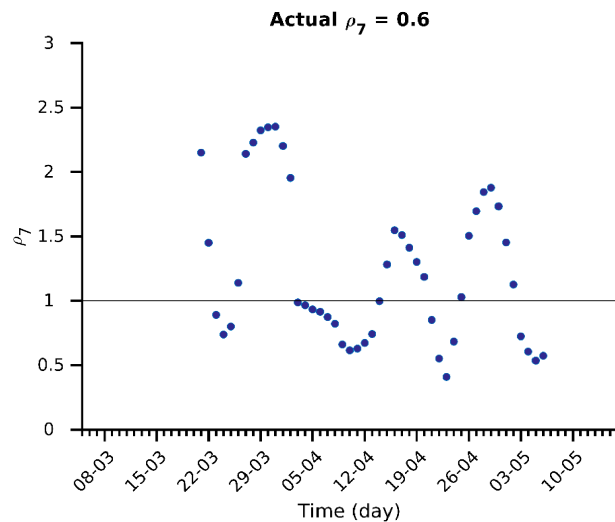
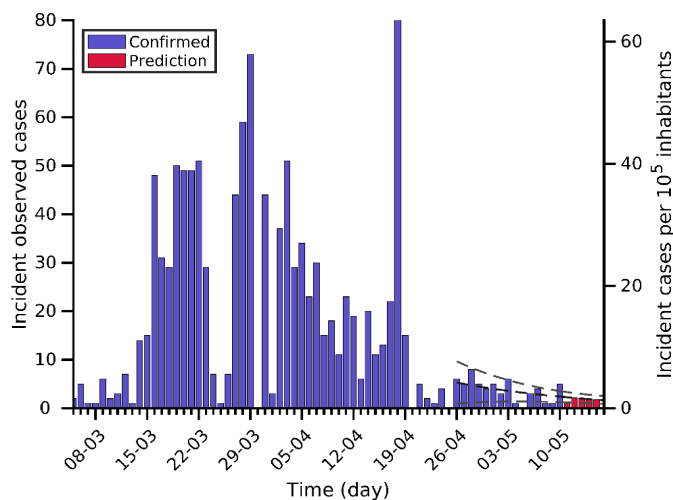
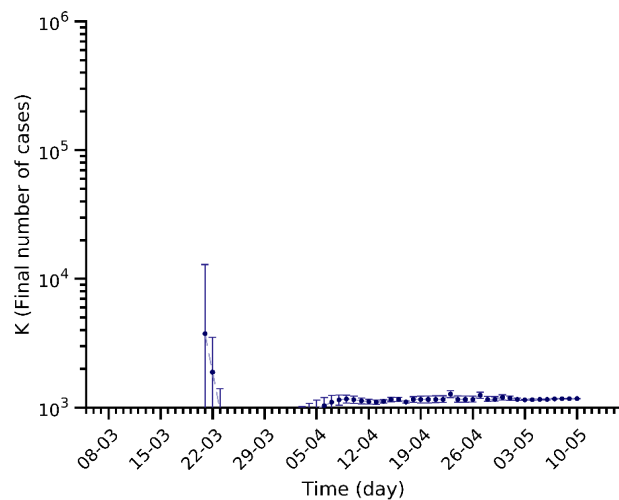
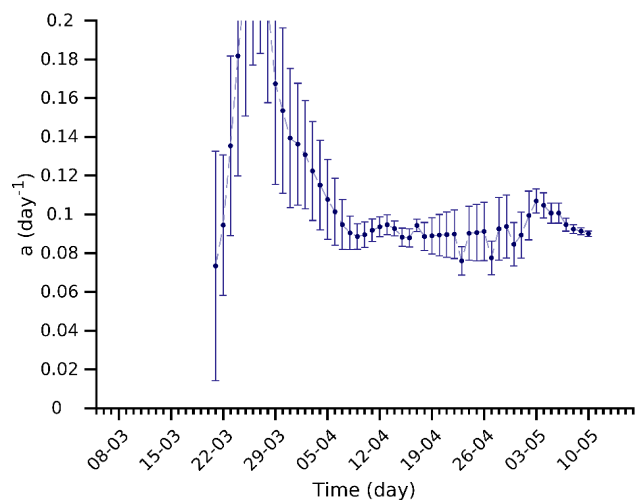
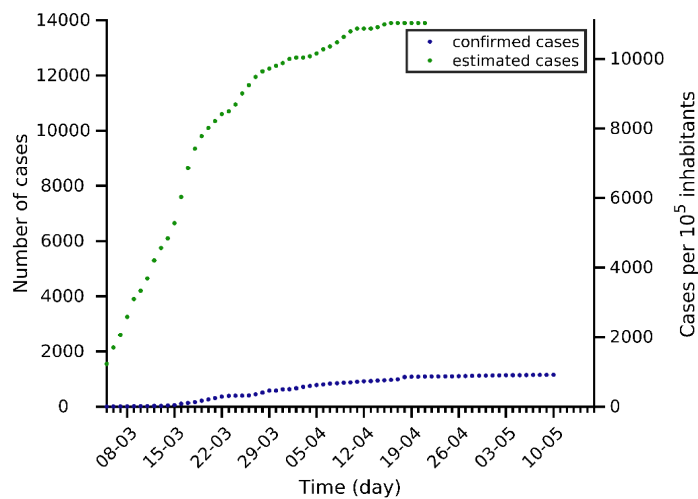
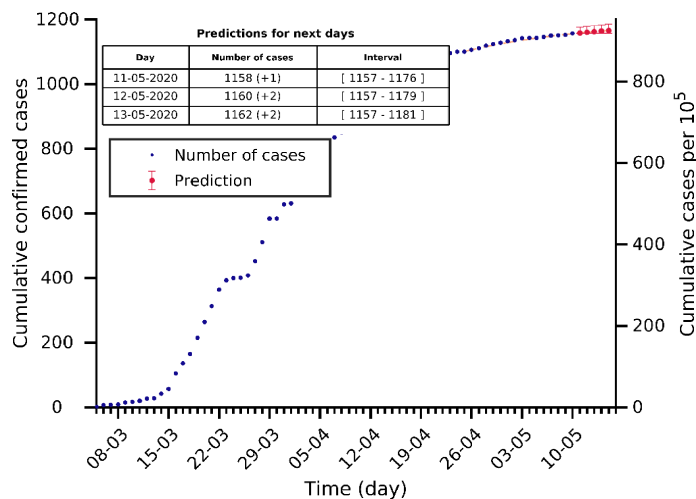
Umbria 10-05-2020. Population: 0.9M. Current cumulated incidence: 160/10⁵



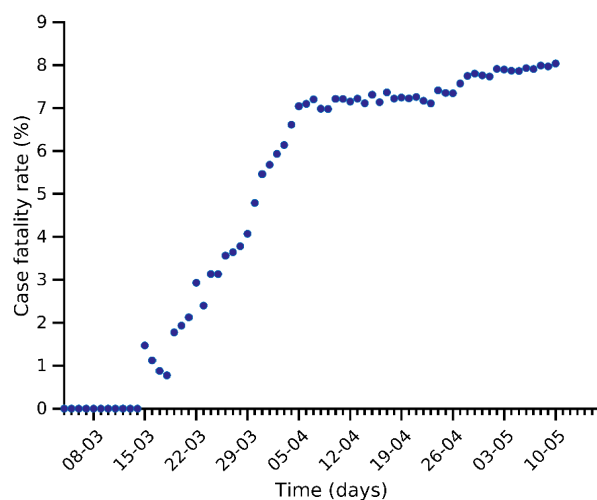
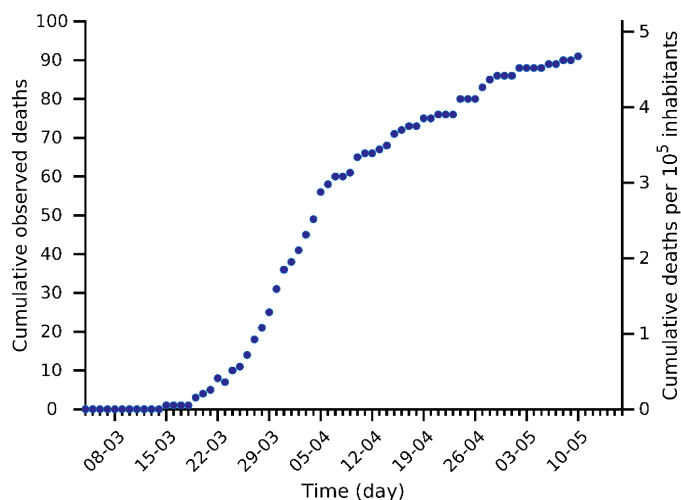
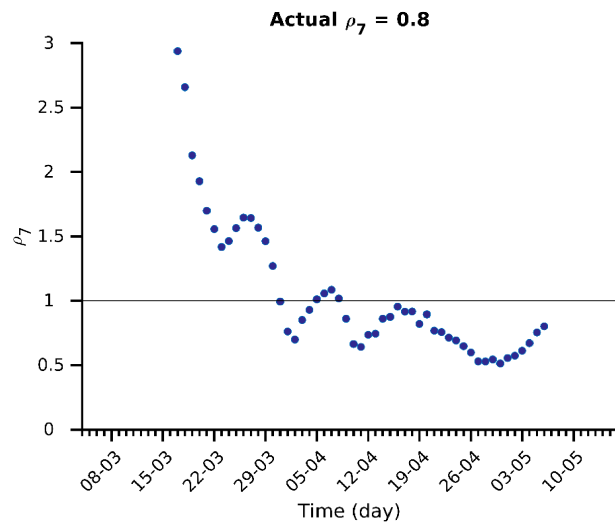
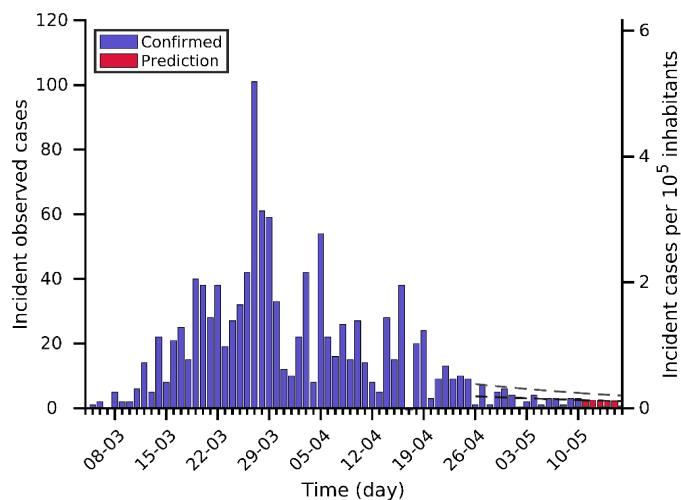
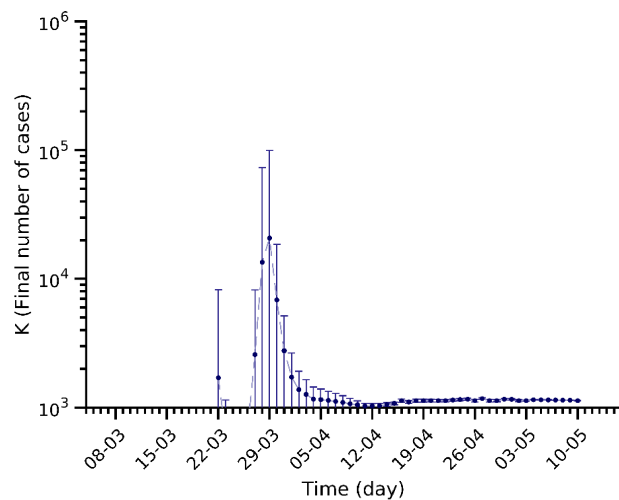
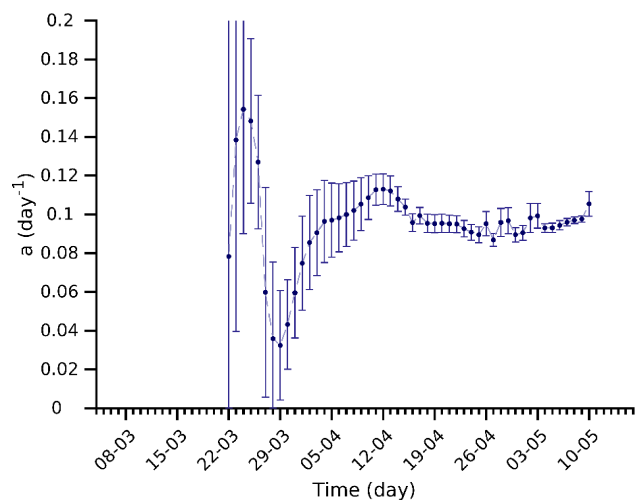
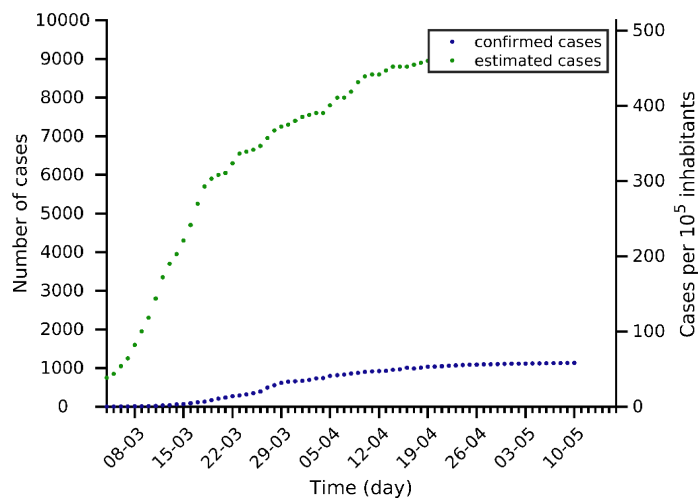
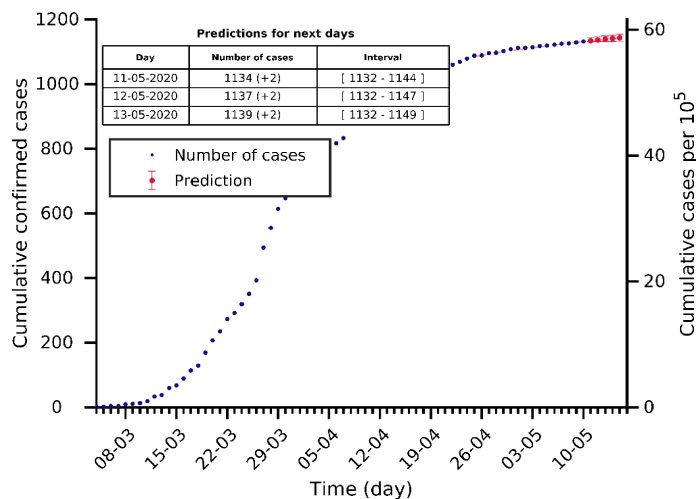
Sardegna 10-05-2020. Population: 1.6M. Current cumulated incidence: 82/10⁵



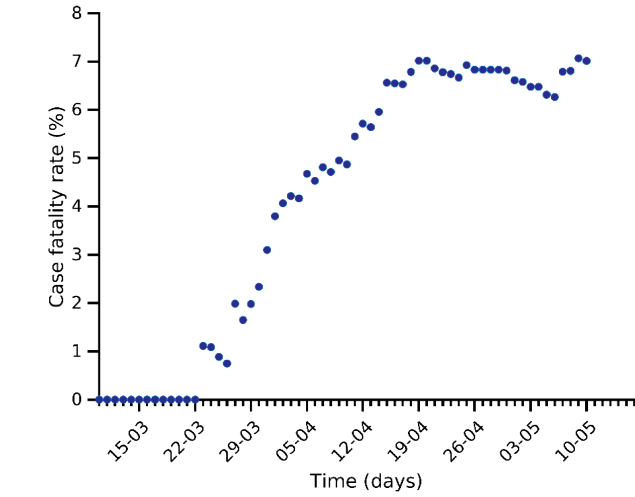
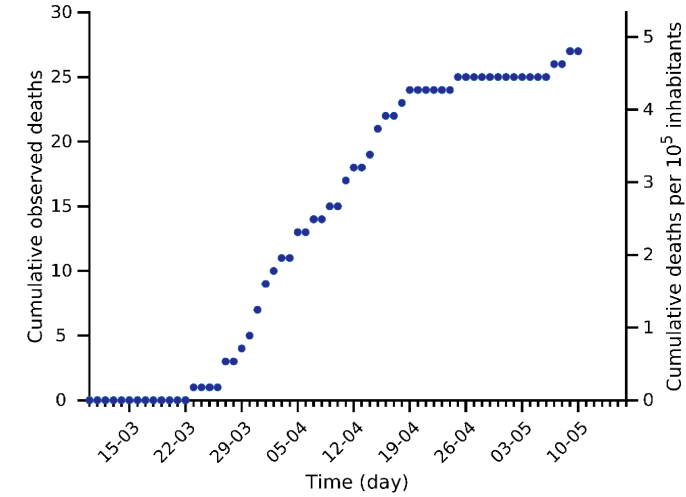
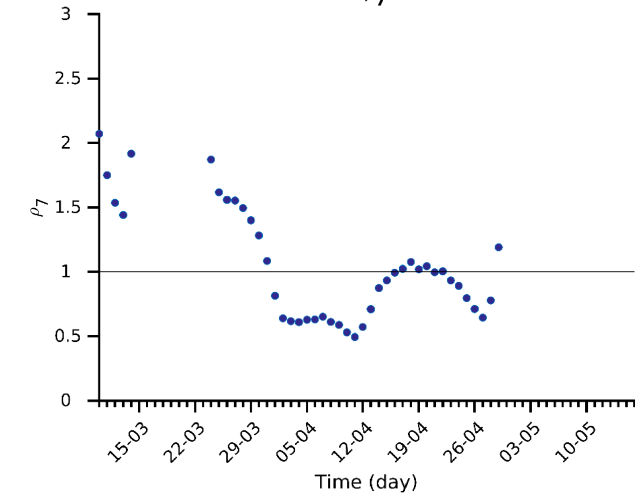
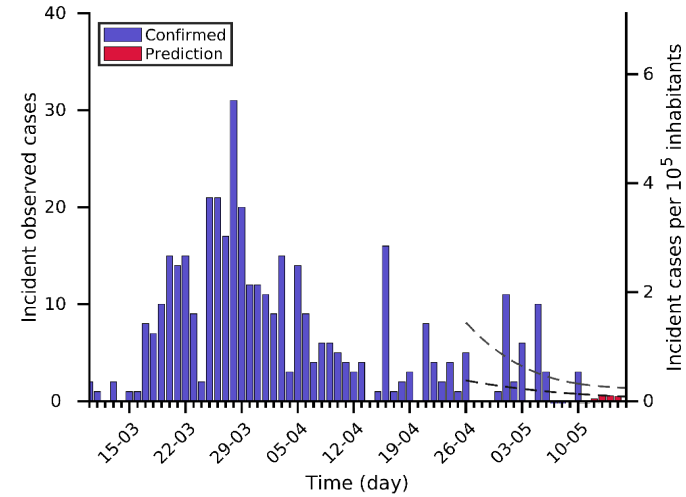
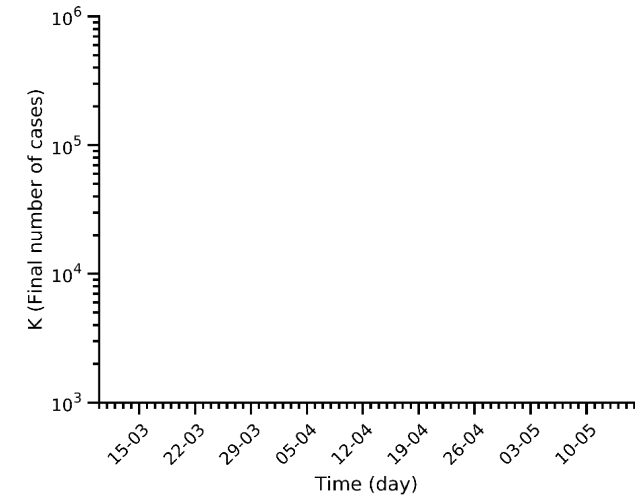
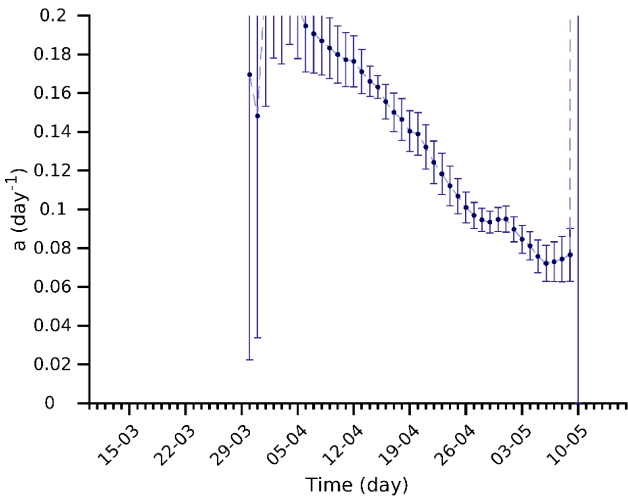
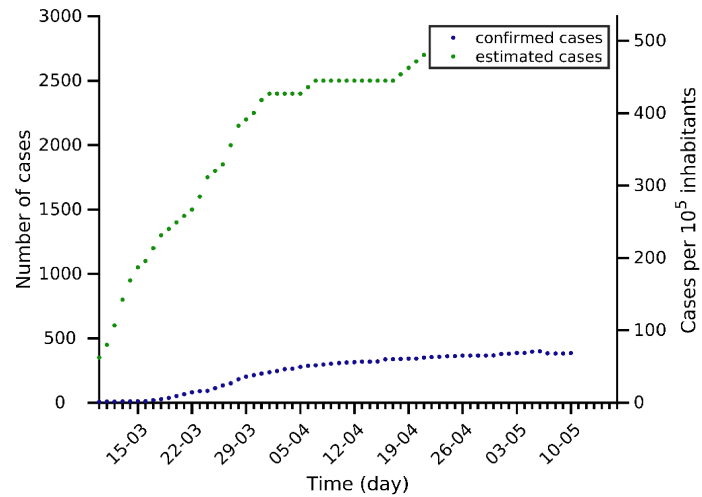
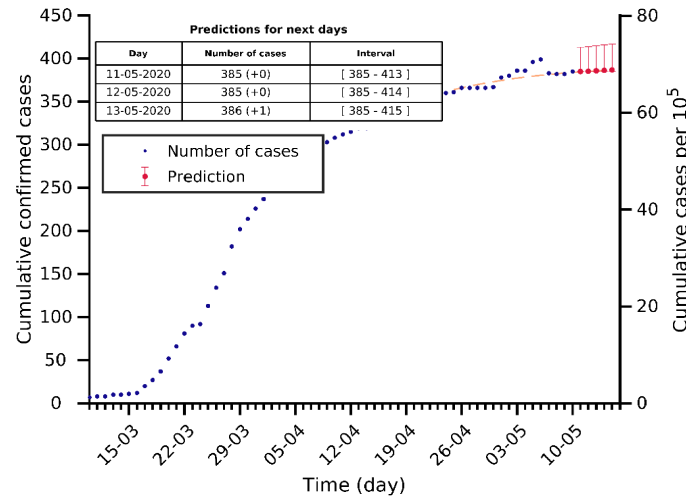
Valle d'Aosta 10-05-2020. Population: 0.1M. Current cumulated incidence: 918/10⁵



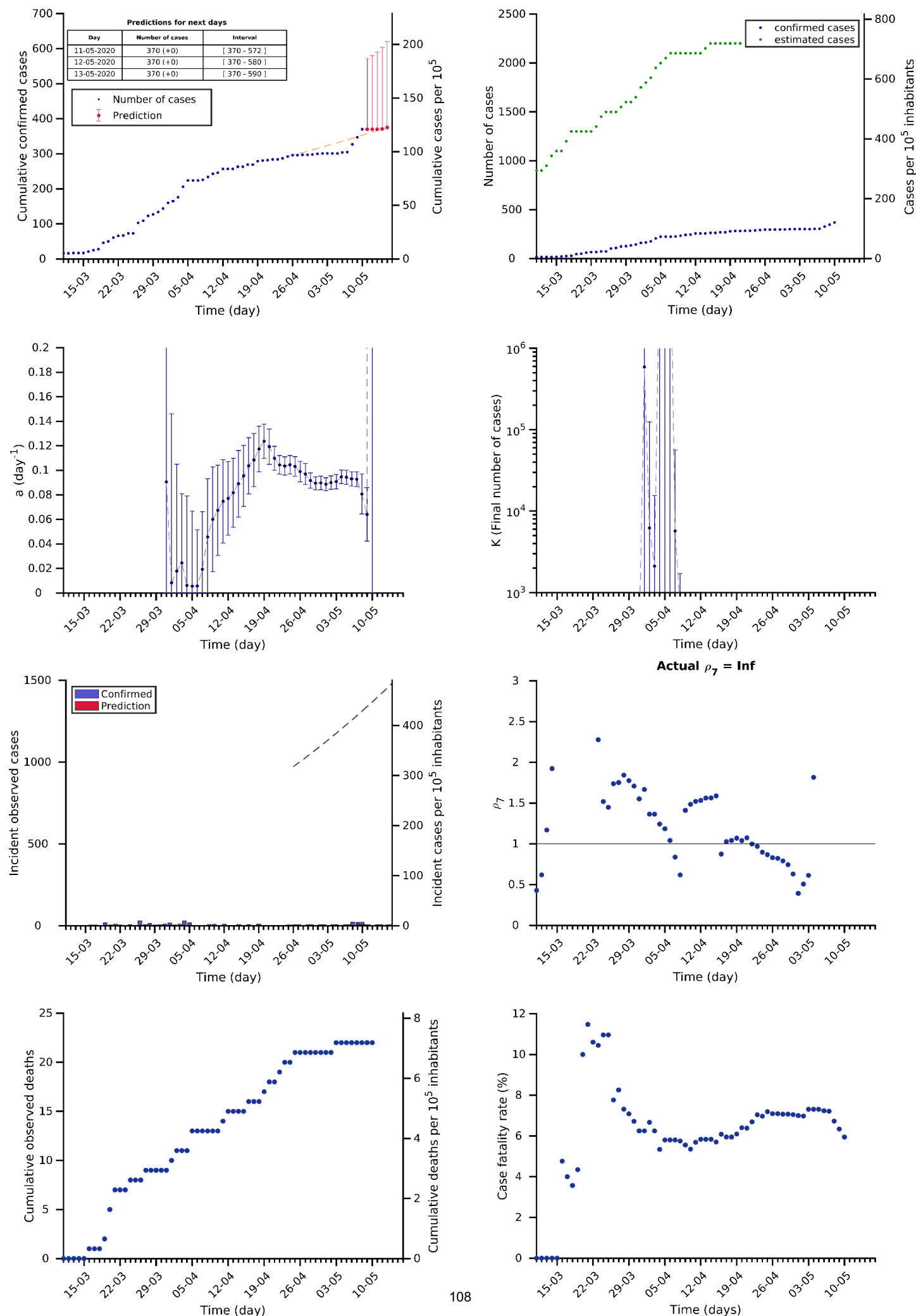
Calabria 10-05-2020. Population: 1.9M. Current cumulated incidence: 58/10⁵



Basilicata 10-05-2020. Population: 0.6M. Current cumulated incidence: 69/10⁵



Molise 10-05-2020. Population: 0.3M. Current cumulated incidence: 121/10⁵



Methods

Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports¹, from European Centre for Disease Prevention and Control (ECDC)² and from Ministerio de Sanidad³. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ($t-1$):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day t .

(3) Classification of countries according to their status in the epidemic cycle

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

¹ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

² <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

³ <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>
<https://github.com/datadista/datasets/tree/master/COVID%2019> , <https://covid19.isciii.es/>

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model⁴ correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-a \cdot (t-t_0)}}$$

where $N(t)$ is the cumulated number of confirmed cases at t (in days), and N_0 is the number of cumulated cases the day at day t_0 . The model has two parameters:

- ✓ a is the velocity at which specific spreading rate is slowing down;
- ✓ K is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which $N(t)$ overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (a and K) and the R^2 of the fitting. At the initial stages the dynamics is exponential and K cannot be correctly evaluated. In fact, at this stage the most relevant parameter is a . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted a with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted K with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if $a > 0.2 \text{ day}^{-1}$, if $K > 10^6$ or if the error in K overpasses 10^6 .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

⁴ Madden LV. Quantification of disease progression. *Protection Ecology* 1980; **2**: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days⁵;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors⁶ in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

⁵ At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

⁶ Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3